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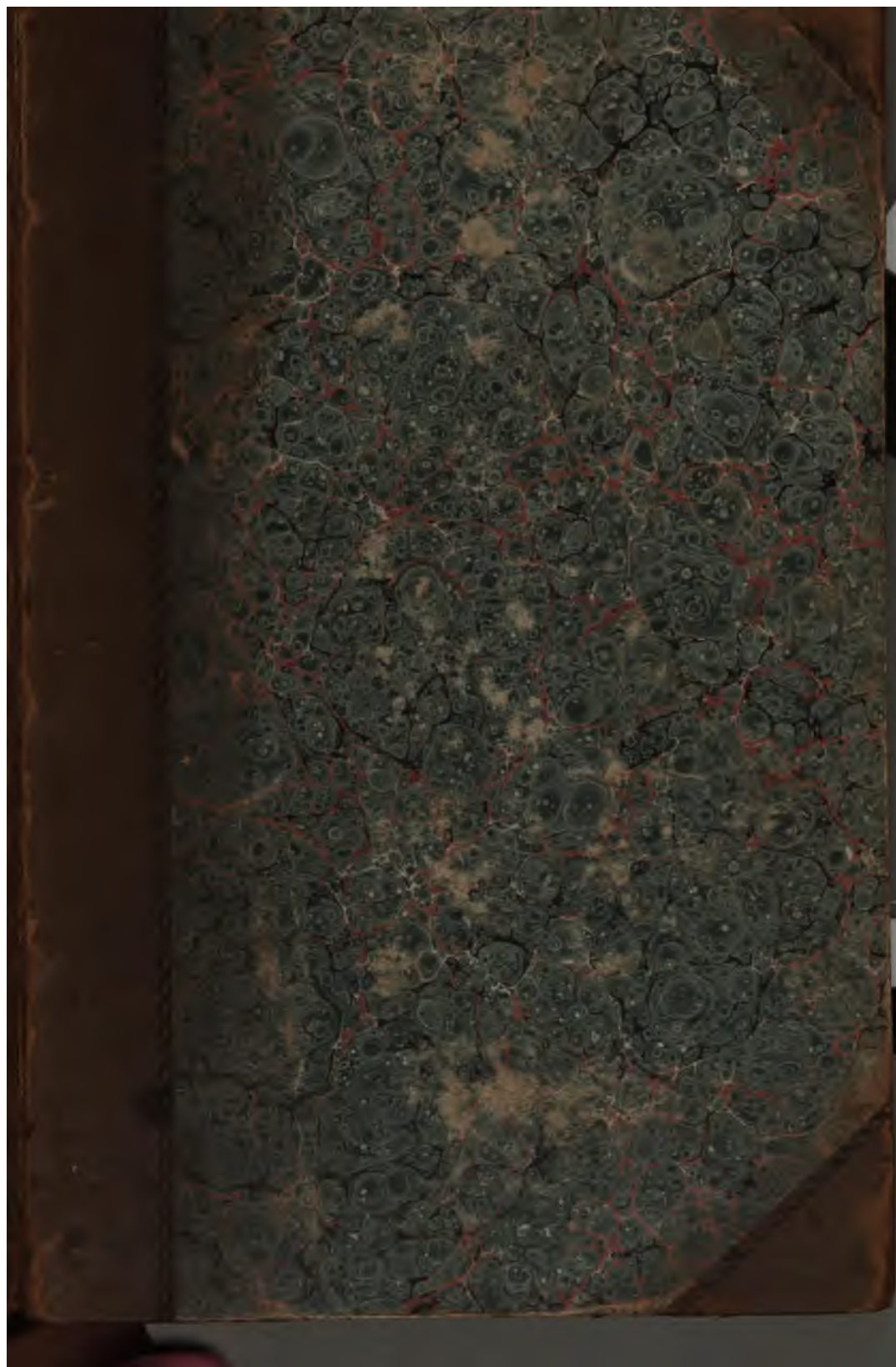
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✓ **OBSERVATIONS** *5th. 1830*

ON THE DIMENSIONS

OF THE *70*

SHIPS OF THE LINE AND FRIGATES

IN THE

FRENCH NAVY.



By M. TUPINIER,

**DIRECTOR OF NAVAL CONSTRUCTIONS, KNIGHT OF SAINT LOUIS,
OFFICER OF THE LEGION OF HONOUR.**

TRANSLATED FROM THE FRENCH BY A BRITISH OFFICER.

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TRANSLATOR'S PREFACE.

THE Memoir which is translated in the following pages was published in the *Annales Maritimes* for 1822 ; it was also printed by order of the French Government at the Royal press, for distribution among its own functionaries. About the same time, the principles developed in it appear to have been adopted as the basis of a new system of construction for the French Navy, which has since, with some slight modifications, continued to be acted upon.

The general character of this system appears to be, to construct after the example of the Americans, ships, which retaining the same denomination of rates as before, shall be severally so superior in force and nautical qualities, as to ensure them a probability of decided advantage over the corre-

sponding classes in other navies. Upon this principle, the two-decked ships of the French navy, which until lately consisted of eighty and seventy-four-gun ships, of descriptions nearly resembling our own, are now replaced, or in the course of being so, by two new rates, one of a hundred 30-pounder guns, and the other of ninety-six 30-pounders. Their Frigates, which were, with few exceptions, armed with 18-pounders, are now chiefly composed either of cut-down seventy-fours, or of two new classes, one of which carries sixty 30-pounders, and the other, fifty-two 24-pounders. They are augmenting the force of their sloops in the like proportion.

The following treatise will show, that it is not merely in the quantity of ordnance, that superiority is aimed at. That point, is considered in its true light, as secondary to the nautical qualities, which alone can render the force of a ship available.

I presume, that there can be no question, as to the right of every country, to prepare its naval, or military means of defence, upon such a scale as may not give reasonable umbrage to its neighbours. But, this new mode of naval construction,

is in fact, anything but defensive ; and though it may not present any ground of alarm as to its final effects, it has a direct present tendency, to put us to heavy expense and inconvenience. We cannot be supposed to view with indifference, the growth of a system, the avowed purpose of which is, in the event of another contest, to work extensive mischief to our commerce, and to assail us with means of annoyance, hitherto unusual in European warfare.

Such a design can however, only be really formidable to this country, so long as we are ignorant of its existence, or inattentive to its progress ; and the French are surely far too sanguine if they calculate upon our being either. It is true, that a very serious difficulty arises, when a new naval system is so skilfully conceived, as to compel us for our own safety, to make a considerable change in our existing force. For, the requisite sacrifices may be very great, as well of the ships we already possess, as in the expense of making suitable preparations. And, as we are so situated, that we cannot remain unconcerned spectators of the rise of a rival power—as it is a necessity of our position, to be not less prepared than other states ; it is of the last moment that our ships

shall be not only adequate to the present occasion, but as much as possible beyond the liability of being again outbuilt. The extent of our Colonial empire, rendering a numerous Navy indispensable to us, the difficulty of modification is greatly increased. But this becomes less embarrassing, in proportion as the rival system approaches such a degree of advancement, that it can neither recede, nor be modified anew, except at an expense which no Government is likely to incur. Then it is, that the requisite force of our ships can be fairly calculated, and that the outlay which the occasion may call for, may be expected to suffice for its purpose.

A very natural inquiry is, “where this system of extension is to stop, and whether it has any determinate limits?” The Author of this Memoir answers a similar question, by declaring, “that in France the augmentation must always remain subordinate to the extension given to the ordnance in the corresponding ships of foreign navies.” It would seem that Frigates are already nearly of the utmost dimensions that can be given to them. Those of sixty guns have almost as much stability, and spread nearly as much canvass, as eighty-gun ships; so that it cannot be well imagined how their

size can be increased, without rendering their sails unmanageable, for the number of men which they can stow. As to ships of the line, it is very probable that the agency of steam, will have a considerable influence in restraining them, within reasonable limits. It is remarkable, that M. Tupinier, has not taken this new power at all into his calculations; though it is obvious, that it has at the present day a direct bearing on the question.

The precise period at which the French system may be supposed to have arrived at the point, at which our corresponding movement in building may be most advantageously made, is a matter for Government to consider and decide upon; and it will no doubt be done with a judicious reference to the principles on which our neighbours have proceeded. These, will be found fully developed in the following Memoir. Respecting the ability of M. Tupinier's performance, there will probably be some difference of opinion. Many may be led to think his views mistaken, and his reasoning inconclusive; and here, as well as in his own country, the change which he so strongly recommends, may be thought no improvement on the old system. Be this as it may, it is certain that his plans have been adopted by

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his Government, and that his principles have regulated the constructions of the last eight years. If, therefore, errors can be detected in his theories, we may profit by the discovery ; while, on the other hand, if they should be consistent with reason and experience, we may possibly find something available for our own use.

It was my intention to attempt a commentary on this Treatise in the shape of notes, in which I meant to examine the practicability of the Author's theories, and how far the principles of his system were applicable to a modification of our own. But I perceived, that a course which might be suitable, and proper, in a work intended for publication, would be inconsistent with my object, which was confined to bringing this Memoir under the notice of those, whose stations, or services, entitle them to hold influential opinions on naval affairs. Those eminent persons, can stand in no need of any suggestion which I could offer.

When I became possessed of this Key of the French System, I was very desirous of obtaining some additional copies ; but having failed in all my endeavours to do so, I decided on translating it in this shape, in order to have it in my power, without

the inconvenience of publicity, to make fully known, where it was desirable that it should be, the important information which it contains.

Whatever relates to the stability of our maritime power, must be a matter of concern to every man who sets a just value on our place among nations.— But to none of the King's faithful subjects can it be more deeply interesting, than to those, who, subsisting on the bounty of their country, may hereafter be entrusted with the defence of her colours. Having the honour to belong to that class, I venture to hope that this humble attempt to be useful, will be received with indulgence; and that I shall not be deemed to have overstepped the limits of professional duty, in thus contributing my mite to "KEEP FOREIGNERS FROM FOOLING US."

I am indebted to the assistance of a scientific friend, conversant with Naval Architecture, for the conversion of the French into English measures throughout the following pages; as well as for the translation of the Notes at pages 22 and 31.

NOTE.

THE following comparison of the French and English weights and measures, has been used throughout this translation.

French.	English.
One millimètre is equal to	.03937 inch.
One centimètre do.	.39371 do.
One mètre do.	39.371 inches.
	lbs. oz. dr.
One kilogramme do.	2 3 5
One metrical ton, } (1000 kilogrammes) } do.	.9853 ton.
A 36-pounder shot weighs	38.88 lbs. English.
A 30 do. do.	32.40 do.
A 24 do. do.	25.92 do.
An 18 do. do.	19.44 do.

Feet and inches are, throughout, English measure, when not otherwise expressed.

ERRATA.

- Page 4, last line, for '21,619' read '2,619.'
 — 11, line 3 from the bottom, for 'inches' read 'metres.'
 — 36, line 1, for 'cubit' read 'cubic.'
 — 49, the dots are omitted before the fractions of English tons in the table.
 — 78, line 11 from the bottom, for 'the presents' read 'the present.'

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OBSERVATIONS
ON THE
DIMENSIONS OF THE SHIPS OF THE LINE
AND FRIGATES
IN THE FRENCH NAVY.

THE system of our Naval Constructions has been for many years subjected to numerous animadversions; and, if some of these have been unjust, there are others which merit serious attention.

Thus, for example, we are accused of remaining stationary, and of letting the English and the Americans take the lead of us in a host of new improvements, which we hardly condescend to imitate even after experience has proved how much they are preferable to our old methods.

This reproach is founded on incontestable facts, which may be traced back to remote periods.

Long before us, the English had generally adopted the practice of sheathing the bottoms of their ships with copper, in order to improve their sailing, and to protect them from being worm-eaten. Before us, likewise, they had ensured a great superiority to their fleets by increasing the number of three-deckers

among their line-of-battle ships ; and they have been still beforehand with us these last thirty years, in constantly increasing the force of their vessels of war, by augmenting the number or the calibre of the guns with which those of each rate have been armed.

It is true, that at the earnest and frequent representations of our Naval Officers the ordnance of our ships has been progressively strengthened. Some officers having stated that the English placed a gun wherever there was room for one in their vessels, the number of cannon on board of all ours was increased ; and, according to recent regulations, the number is to be still farther extended.

Changes of this nature cannot be considered real improvements, except where, the weight being augmented, the capacity of the hull of the ship which has to carry it, is proportionably enlarged.

But, while the inferiority of our naval armaments was the subject of complaint with a great many officers, others exclaimed against the excessive dimensions of our ships of the line. These maintained, that before the general adoption of the plans after which our ships are still constructed, France possessed small ships of the line of superior qualities, which cost much less, which could be managed by fewer men, and which were far less expensive at sea.

It is to this diversity of opinions, that we must not doubt ascribe the retention hitherto, of the established practice ; as that presents, a sort of medium between the two systems,

Rear Admiral the Baron Duperré having his flag on board the *GLOIRE* frigate, and commanding a squadron stationed in the West Indies, anchored in the Chesapeake in the month of September, 1819. Struck with the force of ordnance, and the large dimensions which the Americans gave their ships of the line and frigates, he urgently insisted on the propriety of our adopting the same system of naval construction, without waiting for the circumstances which would impose on us the necessity of doing so.

Similar observations have been repeated by most of the officers of the Royal Navy who have resided in the United States; especially by Captain Montgomery, who had in 1820 been sent to the ports of the Union, to make enquiries respecting steam navigation, and who brought back many interesting documents about the navy and artillery.

So far back as the year 1816, M. Dupin, a naval engineer and member of the Royal Institute, had had opportunities of visiting, in England, several large frigates armed with 24-pounder cannon; and he pointed out then, of what importance it would be to us to have vessels of the same force; and he has since insisted on the necessity of this measure in the second part of his "*Travels in Great Britain.*"

At present, the advocates for vessels of large dimensions are the most numerous; they blame a state of things which does not keep pace with what is doing by other maritime nations; they condemn those motives of economy which make it impossible

for us to become strong, and of which the infallible result must be, to render useless for the glory of our arms, the sums annually appropriated to the expenses of the navy.

An experiment of the highest interest has just taken place in the Mediterranean, and it appears to me that its success ought to be the source of important improvements. This was the transformation of the *ROMULUS*, a ship of the line of 74 guns, into a frigate called the *GUERRIÈRE* of 58 guns.

The *ROMULUS* carried ordnance, of which the total weight amounted to 232,000 kilogrammes, ($228\frac{1}{2}$ tons) without including the shot, powder, &c. The displacement of her hull when fully stored was 2882 cubic metres, the surface of her courses and three topsails was in all 1,962 square metres (21,119 square feet). The height of her lower-deck ports above the water, when fully stored, was only 1 metre 73 centimetres (5 feet $8\frac{1}{10}$ inches.).

This ship of the line, after having been cut down and armed as a frigate, has retained the same principal dimensions; her length on the line of floatation is 54 metres 82 centimetres (179 ft. $10\frac{1}{4}$ inches); her breadth at the midship frame is 14 met. 45 cent. (47 ft. 4 in.), and her depth of hold is 7 met. 14 cent. (23 ft. $5\frac{1}{10}$ in.) but the weight of her ordnance is reduced to 180,000 kilogrammes ($177\frac{3}{10}$ tons) not including the shot, powder, &c.; her draught of water has been diminished by 37 cent. ($14\frac{1}{8}$ inch.); her displacement is now only 2,1619 cub. met.

(92,495 cub. ft.); while, on the contrary, the surface of her six principal sails has been increased to 2,158 square met. (23,228 square ft.); and the height of her battery above the water is now 2 met. 10 cent. (6 ft. $10\frac{5}{8}$ in.).

It follows from this, that independent of the unspeakable advantage of carrying her guns higher out of the water, the GUERRIÈRE has over the ROMULUS that of possessing greater stability, which enables her to spread a much more considerable surface of sail.

I do not wish to establish here, that the stability of vessels of war, is in proportion to the relation which exists between the weight of their guns and the total weight of their whole body; neither do I pretend that with equal force of impulsion their velocity must necessarily increase in the same proportion that the surface of their sails is enlarged with reference to the size of their hulls; I know that these principles, taken in an absolute sense, would be confirmed neither by theory nor experience; but the preceding comparative statements afford, nevertheless, strong grounds for believing in the superior nautical qualities of the *razè* over the original ship of the line.

The trial made with the GUERRIÈRE has completely proved this superiority; and I believe I may conclude from it that, (all the other conditions remaining the same) a vessel in which there should be the same proportion between the principal dimensions of the hull, her total immersion, her displacement, and the sur-

face of her sails, would have the same probabilities of success.

The object of this Memoir is to show the influence which the results of this experiment ought to have in determining the dimensions of the ships of the line, and frigates, which are to be henceforth constructed in our ports.

NECESSITY OF INCREASING THE DIMENSIONS OF
OUR VESSELS OF WAR.

VARIOUS considerations render the augmentation of the size and force of our vessels indispensable.

Whatever may be the extension given to the Royal Navy, during a peace of more or less duration, it is not probable that we shall ever return to the system which succeeded so ill for us during the war of the Revolution, and that we shall send numerous fleets to sea. It is rather to be presumed that our ships of the line of the higher rates will be kept in reserve for the protection of the roadsteads and coasts of the kingdom; while small squadrons of frigates, to which will be added a few only of the smaller ships of the line, will be sent to a distance, to injure the commerce of the enemy wherever the number of his vessels may offer chances of capture.

To carry on a war of this nature, the most essential qualities to be sought for in the vessels employed in it are:—superior sailing, and the most entire security in performing every evolution. These advantages can only be ensured by giving a very great stability, which will allow much sail to be carried in proportion to the dimensions of the hull; and these qualities are incompatible with a quan-

tity of ordnance, excessive, and out of proportion to the remaining weight which a ship has to carry.

Of what advantage would it be to us, to get into the midst of the richest convoys by dint of carrying sail, with vessels armed with a superabundance of heavy cannon, if they are immediately after to fall into the hands of the enemy, because they cannot sail well enough to escape his squadrons?

How highly advantageous, on the contrary, would it not be, if these vessels possessed superior sailing! Whatever they might meet, which was weaker than themselves, they could pursue and compel to fight; while they might easily get away from those which could overpower them. Every thing conspires, then, to render it desirable that French ships should above all things possess superior sailing; and the best means of arriving at that, is to give their hulls very great capacity with respect to the weight which they will have to carry.

Let us farther observe, that if we have no probability of success, except by going to a distance to attack the commerce of the enemy, we must provide for the subsistence of our crews during a considerable lapse of time. For the want of colonies in the greatest part of the globe, there are but few ports where the King's ships could enter during a war, without running the risk of meeting an enemy.

The safety of our expeditions renders it, therefore, essential that the vessels should carry, without being overloaded, provisions for nine or ten months; and,

consequently, that they should have like the *Guerrière*, a hull of very large size in proportion to their ordnance, and to the number of their crews.

Under this last consideration, that frigate may be viewed, as the model of what the King's vessels ought to be, to fulfil the conditions most essential for sailing, and fighting them, to the best advantage.

With a volume of immersed body of 2.619 cubic metres, which may be extended to 2.733 cubic metres, in retaining 2 metres only ($6.6\frac{1}{4}$) for the height of her main-deck ports above the water,* the *GUERRIÈRE* is armed with 58 guns of 36lb. calibre, of which 28 are long guns, and thirty are carronades. She has a crew of 492 men, for which she can carry ten months provisions, four months water, and stores for a year. Her stability is such, that she can carry without danger a surface of sail, almost equal to that of eighty-gun ships, which gives her a great superiority on every point of sailing. Her establishment of stores, &c. though regulated without parsimony, occupies but a moderate proportion of room in the different parts of the vessel, so that there remains ample space for the accommodation of the crew

* When the *GUERRIÈRE* sailed she was only supplied with seven months' provisions, and five months and a half water, which left her 2 metres 10 cents. ($6\text{ft. } 10\frac{3}{4}\text{in.}$) height above the water for her guns; she might therefore take without inconvenience, three months more provisions, by reducing the water to one hundred and twenty days, and the guns would still be 2 metres, ($6\text{ft. } 6\frac{3}{4}\text{in.}$) above the water.—Author's note.

without crowding, and to admit every where that free circulation of air, which is indispensable for dryness, and the preservation of the men's health.

Is it possible to contrive a plan better adapted for uniting all the qualities required in a vessel, which should be intended to cruise in the southern hemisphere, or the Indian seas?

Let us add, that if this frigate were embarrassed by her prizes, her great internal capacity would enable her to receive on board the most valuable part of the cargoes taken from the enemy; a thing impossible for our eighteen pounder frigates, and for our ships of the line, which, already too much loaded with their own armament, have neither convenient room, nor the size of hull necessary for embarking any thing more, without spoiling their qualities by excessive immersion.

OBSERVATIONS ON THE 24 POUNDER FRIGATES,
LATELY ARMED IN OUR PORTS: PROPOSITION
FOR REPLACING THEM BY OTHERS OF LARGER
DIMENSIONS.

THE 24-pounder frigates recently constructed in our ports, are still less satisfactory with reference to the requisite qualities, than those which are armed with 18-pounders.

The scale established on the 12th of May, 1817, for forming the plans of these frigates, directed:—

1st. That they should have, *at most*, an immersed body equal to 2,100 tons of 2,000lbs. each, or 2,004 cubic metres, (the cubic metre of sea water weighing 1,026 kilogrammes) with the following dimensions.

	French.			English.	
	ft.	in.	lines.	ft.	in.
Extreme length from stem to stern on the line of floatation when fully equipped	160	0	0	170	6 $\frac{1}{2}$
Breadth moulded	40	6	0	43	2
Depth of hold at the midship beam .	21	6	0	22	11
Height of the midship port above the water	6	0	0	6	4 $\frac{3}{4}$
Draft of water amidships	19	2	6	20	5 $\frac{3}{4}$
Depth of the keel and false keel . .	1	5	0	1	6
Draft of water above the keel or depth of the immersed body	17	9	6	18	11 $\frac{1}{2}$
Volume of the Parallelopiped circumscribing the immersed body 3953 cubic inches.					

2nd. That they should be armed with thirty
24-pounder guns, two 12 pounders, and eighteen-

36-pounder carronades; ordnance, which with her equipment and stores of shot, powder, &c. would amount to a total weight of 219,000 kilogrammes.

3d. That they should have a complement of 450 men, with provisions for six months, and water for 120 days.

In consequence, the total weight of what was to be carried, was estimated at 1,100 tons, (or 1,077,000 kilogrammes) at most, and that of the hull at 1,000 tons (979,000 kilogrammes); that is to say, that the total weight of the vessel was to be 2,056,000 kilogrammes, corresponding to that of 2,004 cubic metres of sea-water, displaced by the immersed body.

But none of the new 24-pounder frigates had yet been launched, when it was decided (on the 13th July, 1819) that this armament should be augmented by eight 36-pounder carronades, in order to bring it in the whole to 58 guns, of which thirty were to be 24-pounder cannon, ten 18-pounders, and twenty six 36-pounder carronades. The total weight of the ordnance, with its ammunition and necessary stores of all sorts, was thus raised to 249,000 kilogrammes, instead of 219,000 kilogrammes, which was consequently an addition of 30 metrical tons, to what the vessel had to carry.

It is true that by way of compensation the fulness of the immersed body of these vessels was, at the same time ordered to be augmented by 54 millimetres ($2\frac{1}{8}$ inches.) A regulation fixed their complement of

men at 459 for war, and at 359 for peace, while the programme had contemplated a war complement of 450 men only. This arrangement, however, could have had no immediate influence on the weight of their armament, because none of the 24-pounder frigates now at sea have received the complete war establishment. But as it has been deemed necessary to supply them with seven months' provisions, the result has been an excess of weight of about 44 metrical tons.

The weight of the hull, estimated in the original scale at 1,000 tons, or 979,000 kilogrammes, was found to be greater by about 70 metrical tons, either owing to the scantling having been a little increased, or to the unusual precautions taken for rendering their fabric more solid throughout. Besides, the weight of many articles of the rigging and armament had not been justly calculated.

These combined causes produced an excess of weight of about 164 metrical tons; and notwithstanding the care which had been taken to augment the fulness by 54 millimètres ($2\frac{1}{8}$ inches), the height of the guns out of the water was reduced to 1 m. 73 c. (5 ft. $8\frac{1}{10}$ in.) The mean draught of water already augmented, like the fulness by 54 mill. amounted to 6 m. 51 c. (21 feet $4\frac{1}{4}$ inches, and the total volume of immersion was found to be 2,164 cubic mètres, instead of 2,004.

Besides the incalculable inconvenience of carrying the guns so low that they could not be worked with-

out danger when the sea was a little rough, there ensued the additional disadvantage of having to impel through the water a vessel immersed 6. m 51 c. and displacing 2.164 cubic metres of water with the same surface of sail which had been intended for an immersion of 6 m. 24 c. and a displacement of only 2,004 cubic metres. The load-water section remained nearly the same, and the height of the metacentre above the centre of gravity of the immersed body, was necessarily less in proportion to the increase of the volume of water displaced.

The new-24 pounder frigates cannot, therefore, have the superior qualities which were expected in that class of vessels, and which are so eminently possessed by the GUERRIÈRE.*

* The naval architects who drew up the plans of these frigates, were directed to give them no difference in the draught of water, forward and aft. Such an arrangement could only be productive of inconvenience, as experience has proved in the *Jeanne d'Arc* and the *Amazone*. A vessel which has no difference in her draft of water, will have one produced by the slightest breeze which acts upon her sails. Her immersion forward being thus every moment increased, her velocity must be impeded on every point of sailing. And, when close to the wind, the centre of effort of the lateral resistance being brought before that of the sails, and of the centre of gravity of the whole body, there will result an excessive tendency to come in the wind, and the consequent necessity of counteracting it by the helm, at the expense of velocity.

To remedy these defects in the *Jeanne d'Arc* and the *Amazone*, it became necessary to alter their stowage, in order to give them a difference of draught of water forward and aft,

If we desire to construct frigates armed with 58 guns, of which thirty shall be 24-pounder cannon, two 18-pounders, and twenty-six 36-pounder carro-nades ; with a crew of 460 men, and which should be capable like the GUERRIERE of embarking provisions for ten months, and water for 120 days, the principal dimensions must be regulated with a view to the necessity which they will be under of carrying the following weight :—

	Metrical tons.	
Ordnance, its equipment, ammunition, and stores of all sorts	249	
Masts, rigging, stores, &c.	190	
Weight of the crew and their effects, 460 men	46	
Provisions, drink, and firing, for 10 months	391	
Water for 120 days	175	
Provisions of the captain and officers	6	
Boats and divers articles	21	
Indispensable ballast	200	English
		tons.
Total weight to be carried	1278	1259
Estimated weight of the hull	1075	1059
Total weight	2353	2318

The volume, to give the immersed body, should consequently be 2.293 cubic metres ; that is to say,

which had not been intended in their plan of construction. But then, the stern, which had not been built with a view to so great an immersion, was found to be too low in the water, (independent of the immersion caused in the whole length of the ships by the excess of weight put into them): the sea broke violently against the counter, and caused damage, of which the smallest inconvenience, was the great quantity of water taken in on the main-deck and in the cabins.—Author's note.

289 cubic metres more than that which was fixed by the scale of the 12th of May, 1817.*

* To establish this summary estimate of what would be the weight to carry, as well as in those which will follow, I have taken for the bases of my calculation those of the scale of the 12th of May, 1817, relative to the new 24-pounder frigates.

Their ordnance, with what belonged to it, was then estimated at 224 tons, or 219,000 kilogrammes; but in consequence of the augmentation which it received by the order of the 13th of July, 1819, it amounted in reality to 249,000 kilogrammes. For all the following plans of establishment, I have estimated from similar data.

	Kilogrammes.
That a 36-pounder cannon, with its carriage, stores ammunition, &c. &c. weighs	6960
30 ditto	5980
24 ditto	5000
18 ditto	3380
36-pounder carronade	3520
30 ditto	3090
24 ditto	2660

The masts, the rigging, the stores, &c. are estimated at 18 per cent. of the supposed weight of the hull of the vessel.

Each man of the crew is reckoned to weigh, with his effects, 100 kilogrammes ($220\frac{1}{2}$ pounds.)

The provisions for each man, including drink and firing, and wood for stowing the hold, are estimated at 85 kilogrammes per month ($187\frac{1}{2}$ pounds.)

The weight of the water for a month, including the weight of casks or the iron tanks, is estimated at 95 kilogrammes for each man ($209\frac{1}{2}$ pounds.)

These data, founded on those of the 24-pounder frigates, appear to me to be sufficiently exact.

But I have thought it necessary to add an item for different

But a new circumstance seems to me to require that there should be some change in the classification of our vessels of this kind. It was decided in 1820, that a new calibre should be added to those at present in use in the Royal Navy, and 30-pounder cannon, and carronades, will be cast without delay in the founderies of that department.

Sixty of these guns, of which 30 should be cannon, and 30 carronades, would be an excellent armament for a frigate of an intermediate class between the 36-pounder razés, such as the *GUERRIÈRE* and frigates carrying 24-pounders.

The sixty guns of the latter, should be completed by 24-pounder carronades, instead of those of 36, which they at present carry ; always understanding that in both classes, two of the upper deck carronades, may be replaced by two cannon of equal weight, for chase guns ; provided this change should be deemed indispensable.

There will result, then, from my proposition, two classes of Frigates, armed with 60 guns of the articles not foreseen by the regulations, and which, with the boats and their furniture, amount to no less than two per cent. of the whole remaining weight to be carried.

It is to forgetfulness on this head, and to the weight of the hull of 44-gun frigates being almost always estimated too low, that we must attribute the height of the guns of those ships above the water being reduced to 1 met. 95 cen. (6 ft. 4½ in.) at most, while according to the original plans and the establishment, this height ought to be 2 met. 11 cen. (6 ft. 11 in.)—
Author's note.

same calibre ; of 30-pounders for the first class, and of 24-pounders for the second.

The following are the details of the establishment, of what these vessels would have to carry, compared with that of the *GUERRIÈRE*.

	The Guerrière.		New Frigates.			
	28 long guns and 30 carronades, 36-pounders.		30 long guns and 30 carronades, 30-pounders.		30 long guns and 30 carronades, 24-pounders.	
	met. tons.	English tons.	met. tons.	English tons.	met. tons.	English tons.
Ordnance, with its stores of all kinds	300	295½	272	268	230	226½
Masts, rigging, and stores . . .	242	239½	216	212½	190	187½
Weight of the crew and their effects	50	49½	48	47½	46	45½
Provisions, drink, and fuel, for 10 mon.	425	418½	408	402	391	385½
Water for 120 days	190	187½	182	179½	175	172½
Provisions for captain and officers	8	7¾	7	6¾	6	5¾
Boats, and various articles	24	23½	23	22¾	21	20¾
Ballast	220	216½	210	206¾	200	197
Supposed weight of the hull . . .	1.345	1.325½	1.200	1.182½	1.075	1.059½
Total	2.804	2.762½	2.566	2.528½	2.334	2.299¾
Corresponding immersion of the hull } which should be given . . . }	cubic metres.		cubic metres.		cubic metres.	
	2.733		2.500		2.275	
	cubic feet.		cubic feet.		cubic feet.	
	96.522		88.293		80.346	

* With this total weight of 2.804 metrical tons, which supposes 10 months' provisions, and 120 days' water for 500 men, the *Guerrière* would carry her ports only 2 metres (6 ft. 6½ in.) above the water, instead of 2 m. 10 cen. (6 ft. 10½ in.) which she does at present.

It will be the same with the two other classes of Frigates. When these vessels leave a French port with 10 months' provisions, the height of their ports will be only two metres. This will suffice for all the purposes of sailing and fighting ; and after two months' cruising, the height will be 2 metres 10 centimetres. (6 ft. 10½ in.) But a greater emersion might be injurious to the stability of the ship, and it will be necessary to replace by

We must now proceed to determine what ought to be the principal dimensions of the two new Frigates; the one, armed with 30-pounder cannon and carronades, and the other with 24-pounder cannon and carronades; and of which the first will displace 2.500 cubic mètres of water, and the latter 2.275 cubic mètres.

If it were only required to follow exactly the ratio, which exists between the analogous dimensions of the *GUERRIÈRE*, all would be reduced to simple calculations of proportion.

But, it must be observed, that that Frigate, has what may be said to be a superabundant stability, owing to her topsides, which were originally those of a 74-gun ship, having been lightened of the weight of an entire deck; of 2 metres, 27 centimetres, (7 ft. 5 $\frac{3}{4}$ in.) height of side; and of about a third of the ordnance which she before carried.

Similar proportions would not be suitable for smaller vessels, because they would give them a

salt-water the weight of the daily consumption after the first sixty days.

Two metres, and two metres 10 cen. are the limits between which the height of the ports of these Frigates above the water ought to be kept.

I shall farther observe, respecting the *Guerrière*, that the above plan of establishment, supposes a crew of 500 men, while, according to her original plan, that Frigate ought to have a war complement of only 492 men; but it is probable that this number will be found too small, considering the great dimensions of her masts and sails.—Author's Note.

fulness of form, which would be as injurious to their nautical qualities, as it would be favourable to those of a Frigate armed with fifty-eight 36-pounder cannon and carronades.

We may, therefore, consider as the highest limit or *maximum* of the proportions to establish between the dimensions of vessels of this kind, those which exist between the principal dimensions of the GUERRIÈRE. The other limit, or the *minimum* of these proportions, is found in the 18-pounder Frigates of Baron Sané, which have no excess of stability, although they possess sufficient for the most difficult situations which they may be placed in at sea.

These Frigates, which were originally intended to have a height for their guns of 2 metres 11 centimetres, (6 ft. 11 in.) have none of them more than 1 metre 95 centimetres (6 ft. $4\frac{3}{4}$ in.) at most, when they are completely equipped, with six months' provisions, and 120 days' water. They then displace a volume of water of 1384 cubic metres; and as the solidity of the parallelopiped circumscribing their immersed body is at this degree of immersion 2711 cubic metres, the ratio of the first of these volumes to the second is $\frac{1384}{2711} = 0.51$.

In the GUERRIÈRE, the analogous ratio is expressed by the fraction $\frac{2733}{4712} = 0.58$.

Hence, the ratio to establish between the volume

of the immersed body of each of the new Frigates, and that of the paralleliped circumscribing it, ought to be between the fractions 0.58 and 0.51.

Calculated with reference to the displacement which is deemed indispensable, this ratio would be 0.568 for the Frigate of sixty 30-pounder cannon and carronades, and 0.555 for the Frigate of sixty 24-pounder cannon and carronades. But as the analogies which lead us to these results are not susceptible of rigorous demonstration, and as it may be justly observed, that the 18-pounder Frigates taken here as a limit, have too little displacement relative to their dimensions, especially towards their extremities ; it would be preferable to approach a little nearer to the proportions of the *GUERRIÈRE*, and to adopt the fractions 0.57 and 0.56, for the ratio to be established between the volume of the immersed bodies, and the circumscribed parallelipeds, in the two new classes of Frigates.

Consequently, for the 30-pounder Frigate, the contents of whose immersed body should be 2.500 cubic metres, that of the circumscribed paralleliped, to the ratio of 0.57, would be 4.386 cubic metres ; and for the 24-pounder Frigate, the contents of the immersed body being 2.275 cubic metres, and its ratio with that of the circumscribing paralleliped 0.56, this last ought to be 4.062 cubic metres.

Passing to the adjustment of their principal dimensions, the same reasons induce me to establish

between them, proportions which will be intermediate, between those which exist in the *GUERRIÈRE** and those of the 18-pounder Frigates of Baron Sané; and I therefore propose the adoption of the following :—

Principal dimensions of the immersed body.	30-pounder frigates.			24-pounder frigates.		
	m.	c.	ft. in.	m.	c.	ft. in.
Length at the line of floatation .	54	00	177 2	53	00	173 10½
Breadth moulded .	14	10	46 3	13	70	44 11½
Mean depth of immersed body .	5	76	18 10½	5	60	18 4½
N. B. The other dimensions which it is essential to attend to, are as follows : viz.						
Height of the ports above the water	2	00	6 6½	2	00	6 6½
Height of the portsills above the beam amidships	0	78	2 6½	0	75	2 5½
Depth of hold amidships .	6	98	22 10½	6	85	22 5½
Depth of the keel and false keel	0	56	1 10	0	55	1 9½
Total depth of water amidships	6	32	20 8½	6	15	20 2

* I have determined upon the principal dimensions of these ships by the following method :—

In the *Guerrière*,

The length on the water-line = $54^m, 82 = L$;

Breadth moulded = $14, 45 = l$;

Mean depth of the immersed
body = $5, 95 = h$;

Content of parallelopiped described about the immersed body
= $L.l.h = 4712^{ms} = P$

Solid immersed = $2733^{ms} = V$;

Ratio of the solid immersed to the circumscribed parallelopiped = $\frac{V}{P} = \frac{2733}{4712} = 0, 58 = r$.

Also, in Baron Sané's 18-pounder Frigate,

The length on the water-line = $46^m, 78 = L'$;

Breadth moulded = $11, 90 = l'$;

Hitherto I have calculated on the supposition that no 36-pounder Frigates would be adopted, except

Depth of the immersed body
(the height of the ports being
1 metre 95 centimteres) = 4,87 = k' ;
Content of the parallelopiped described about the immersed
body = $L'.l'.k' = 2711^{\text{ms}} = P'$;
Solid immersed = $1384^{\text{ms}} = V'$;
Ratio between these last two solids,
$$= \frac{V'}{P'} = \frac{1384}{2711} = 0,51 = r'.$$

Again, in the proposed intermediate Frigates,
Let the length on the water-line = x ;
Breadth moulded = y ;
Depth of immersed body = z ;
Content of the parallelopiped de-
scribed about the immersed body .. = $x.y.z = N$;
Solid immersed = M ;

Ratio between these last two solids = $\frac{M}{N} = R.$

Now, if there should exist among the values of x , y , and z ,
the same relation as among the corresponding values for the
Guerrière, we shall have

$$x : L :: y : l :: z : h :: \sqrt[3]{N} : \sqrt[3]{P} :: \sqrt[3]{\frac{M}{R}} : \sqrt[3]{\frac{V}{r}};$$

$$\text{Therefore } x = L \sqrt[3]{\frac{M.r}{V.R}}; y = l \sqrt[3]{\frac{M.r}{V.R}}; z = h \sqrt[3]{\frac{M.r}{V.R}}.$$

If, instead of the *Guerrière*, we take the 18-pounder Frigate,
we shall find

$$x = L' \sqrt[3]{\frac{M.r'}{V'.R}}; y = l' \sqrt[3]{\frac{M.r'}{V'.R}}; z = h' \sqrt[3]{\frac{M.r'}{V'.R}}.$$

But in considering, as I have proposed, the *Guerrière* and
Baron Sané's 18-pounder Frigate, as two limits, between which

such ships of the line as should be razéd. But it is probable, that when there shall be no more 74-gun

it is necessary to keep, we are led to take between the preceding expressions for x , y and z , the following mean values :

$$x = \sqrt{L.l} \sqrt[3]{\frac{M.r}{V.R}} \sqrt[3]{\frac{M.r'}{V'.R}} = \sqrt{L.L'} \sqrt[3]{\frac{M^2.r.r'}{R^2.V.V'}}$$

$$y = \dots \dots \dots \sqrt{l.l'} \sqrt[3]{\frac{M^2.r.r'}{R^2.V.V'}}$$

$$z = \dots \dots \dots \sqrt{h.h'} \sqrt[3]{\frac{M^2.r.r'}{R^2.V.V'}}$$

Formulæ which are applicable to all the intermediate Frigates between the *Guerrière* and the 18-pounder Frigate, and in which M and R are the only variable quantities.

These formulæ are, at most, only a means of facilitating the calculations; they are founded upon the supposition, that the dimensions of the *Guerrière* must be taken as the *maximum*, and those of the 18-pounder Frigate the corresponding *minimum*: it is, therefore, easy to conceive that this supposition is not susceptible of a rigorous demonstration.

By applying the preceding results, I find that in the Frigate armed with 30-pounder guns, M being = 2500, and $R = 0.57$, we shall have $x = 54^m.16$; $y = 14^m.05$, and $z = 5^m.76$.

And that, in the 24-pounder Frigate, in which $M = 2275$ and $R = 0.56$, we obtain $x = 52^m.85$, $y = 13^m.68$, $z = 5^m.62$.

But in order to get rid of fractions, which cause great increase in the labour of calculating, but which, nevertheless, do not much affect the results of the calculations, I have determined upon the following dimensions for the two classes of frigates.

$$\begin{aligned} \text{1st, 30-pounder Frigate} & \left\{ \begin{array}{l} x = 54^m.00 \\ y = 14 .10 \\ z = 5 .76 \end{array} \right\} x.y.z = 4386^m.3 \\ \text{2nd, 24-pounder Frigate} & \left\{ \begin{array}{l} x = 53^m.00 \\ y = 13 .70 \\ z = 5 .60 \end{array} \right\} x.y.z = 4066^m.3 \\ & \text{instead of } 4062^m. \end{aligned}$$

ships to cut down, and when some mode of construction shall be discovered which may supersede the ne-

The present 24-pounder frigates are 51 m. 97 c. long, 13 m. 16 c. broad; the depth of the immersed body is 5 m. 78 c.; the height of ports is 1 m. 95 c. This is not considering the 54 millimetres that were added to the fulness and draft of water after they were laid down. If, instead of fixing upon 2004 cubic metres (2100 tons), as the *maximum* of displacement, and of establishing between this displacement and the content of the circumscribed parallelepiped, the ratio of 0.507 (which is even less than that of Baron Sané's 18-pounder frigate, which is 0.510) it had been left to the Naval Architects to regulate the solid immersed as they might have thought proper; those among them who would have adopted the ratio of 0.56, determined by what precedes, for this class of ships, would have given a displacement of 2,214 cubic metres, only 79 cubic metres less than what I have shown to be necessary for carrying their present ordnance, with provisions for ten months and water for 120 days. Thus their frigates would have retained 1 m. 95 c. of height of ports, with provisions on board for eight months and water for four months.

It is then much to be regretted that the competitors were limited to a *maximum* of displacement of 2004 cubic metres, which experience has proved to be insufficient; and to which alone is to be attributed the excessive fineness of body under water of the 24-pounder frigates, especially towards the extremities.

Nevertheless, even admitting that the form of body given to the new frigates had allowed of sufficient displacement, it is still unfortunate that their breadth should have been fixed at 13 m. 16 c. only, for a depth of immersion of 5 m. 78 c.; whilst the preceding calculations, founded on bases which have been tried in the 18-pounder frigates and in the *Guerrière*, would fix these dimensions at 13 m. 68 c. and 5 m. 62 c. respectively; the relation between these two dimensions having so great an effect upon the stability. It, therefore, appears to me, to be indis-

cessity of using the largest kinds of timber, it will be found advantageous to construct Frigates of that class. I shall proceed to examine what dimensions it will be desirable to give them.

Those of the *GUERRIÈRE* would, strictly speaking, suffice, if the armament of the proposed frigates were limited to twenty-eight 36-pounders on the main deck. But it would be preferable to give them thirty, with an equal number of carronades of the same calibre on the upper deck, which would be in all sixty guns, as in the intended 30 and 24-pounder Frigates.

The length of the *GUERRIÈRE*, 54 met. 82 cent.

pensable to abandon entirely the dimensions which are given in the programme of the 12th of May, 1817, even though we should leave it in the power of the Naval Architects to increase their displacement at pleasure.

The superior Commission, which was appointed to inspect the *Clorinde* at Cherbourg, at the time when her armament was completed, have, in their report (of 30th of July, 1821), made some very just remarks upon the want of capacity of that frigate with respect to the force of ordnance, and the total weight which she had to carry. They observed on that occasion, that if it were desirable to have good frigates carrying 60 guns, it would be necessary to increase the displacement of those which should hereafter be built, by assimilating them to the dimensions of the American frigate the *Constitution*; and as these dimensions were wanting, they expressed a wish that 24-pounder carronades should be substituted for the 36-pounders on the quarter-deck and forecastle of the *Clorinde*.

Mons. Bretoq, director of Naval Constructions, who planned this latter frigate, was a member of the Commission.—Author's note.

would then be no longer enough with reference to the size of the ports, and the distances between them, fixed by the regulations for 36-pounder cannon; and 56 metres of length at least would be necessary. The 80-gun ship of the line has 58 met. 47 cent. for her battery of thirty 36-pounder long guns.

The establishment of what this frigate would have to carry would be as follows.

	met. tons.
Ordnance, with its stores and ammunition	314
Masts and stores	242
Crew, with their effects (510 men)	51
Provisions, firing, &c. for 10 months	434
Water for 120 days, including tanks	194
Provisions for captain and officers	8
Boats, and sundry articles	25
Ballast	230
Supposed weight of the hull (same as the Guerrière)	1345
Total	2843

Which 2843 metrical tons correspond to a volume of immersed body of 2770 cubic metres.

In keeping the same ratio as in the GUERRIÈRE (0. 58) between that volume and that of the circumscribing parallelopiped, the latter would be 4776 cubic metres.

The GUERRIÈRE having an excess of stability, the breadth of the 36-pounder Frigate might be reduced to 14 met. 40 cent. instead of 14 met. 45 cent. while her length would be greater by 1 met. 18 cent. and then the depth of her immersed body would be found sufficient at 5 met. 92 cent. instead of 5 met. 95 cent.

Assuming these data, the dimensions of the intended 36-pounder frigate would be the following.

	m.	c.	ft.	in.
Length on the loadwater line	56	00	183	8 $\frac{3}{4}$
Breadth moulded	14	40	47	3
Depth of immersed body	5	92	19	5
Height of the ports	2	00	6	6 $\frac{3}{4}$
Height of the portsill above the beam amidships	0	82	2	8 $\frac{1}{4}$
Depth of the hold amidships	7	10	23	3 $\frac{1}{2}$
Depth of the keel and false keel	0	58	1	10 $\frac{7}{8}$
Draught of water amidships	6	50	21	4

And the *minimum* of the volume of her immersed body would be 2770 cubic met. 97,828 cub. feet.

CONCERNING THE SURFACE OF SAIL FOR
THE NEW FRIGATES.

THE principal dimensions of the new Frigates being regulated, it remains to be seen, what will be the surface of sail necessary for giving them the greatest possible velocity, without compromising their safety. This is one of the most essential points to consider, in preparing the plans of new vessels; unfortunately, enough importance has not always been attached to it.

The established usage in our ports, and which is laid down in all the treatises on the art of masting, is, to fix the length of a vessel's masts in proportion to her breadth at the water-line; and those of the yards, in fractions of her length; from whence it follows, that the surface of the sails is proportioned to the rectangle circumscribed by the water-line.

Thus, the same surface of sail is given to two vessels of the same length, and of equal breadth, of which the immersed bodies differ essentially in depth, form, and capacity. It often follows, that the sail which is insufficient to give due velocity to one vessel, which has an excess of stability, is, on the contrary, too much for another, and dangerous for

her in bad weather. It would therefore be rendering an important service to the navy to calculate anew, on better understood data, the tables which serve for fixing the dimensions of the masts, yards, and sails of vessels of all classes. But this labour would require a length of calculation inconsistent with the plan which I have laid down for myself. However, as the particular object of this memoir is to determine the proportions which should be established between the principal dimensions of the frigates and ships of the line, which are in future to be laid down in our ports, it will not be without utility to point out at the same time, the surfaces which it will be suitable to give their most essential sails.

In considering the component elements of the formulæ, which serve to describe the stability of floating bodies, we may look upon it as sufficiently accurate in practice to establish, that for vessels of the same kind, of which the height of upperworks is nearly the same, and which only differ from each other in the form and dimensions of their topsides,—the impelling powers respectively suitable, may be calculated in proportion to the surface of floatation, and the height of the metacentre, above the centre of gravity of the immersed body of each vessel. From whence we are led to establish, that the surface of sail of these same vessels may be regulated, *in direct proportion to the length of each, multiplied by the cube of her breadth, and having for divisor the product of the depth of her immersed body*

*into the ratio existing between the volume of this immersed body and that of the circumscribing parallelopiped.**

I must beg that it may be well understood, that I do not advance this principle as being susceptible of rigorous demonstration; but in the present state

* I will call L , l , h , and V , the length, breadth, depth, and immersed solid of a ship; r , the ratio between this solid and the circumscribed parallelopiped; S , the surface of sail.

Also, let L' , l' , h' , V' , r' , S' represent the corresponding terms for a similar ship.

As we have only to deal with ships which differ but little in form, we may substitute for the formula $\frac{\int S y^2 dx}{V}$, which expresses the height of the metacentre above the centre of gravity of displacement, the following: viz. $\frac{L l^3}{V} = \frac{L l^3}{(L. l. h.)r} = \frac{l^2}{h r}$; and since, for the same reason, the ratio of the plane of floatation to the circumscribing rectangle, may be considered as nearly constant, the surface of sail may be taken as proportional to this rectangle multiplied by the preceding quantity $\frac{l^2}{h r}$ which represents, similarly, the corresponding height of the metacentre; that is, S will vary as $L. l. \frac{l^2}{h. r} = \frac{L l^3}{h r}$.

The following proportion will therefore exist between two vessels of the same class:—

$$S : S' :: \frac{L. l^3}{h r} : \frac{L' l'^3}{h' r'}$$

$$\text{whence } S' = S \times \frac{L' l'^3 h r}{L l^3 h' r'}$$

There results from this,

1st. That when the comparison is made between two ships of the same breadth, the same depth of immersed body, and the

of the art of ship-building, it appears to me that the use of it for regulating the respective dimensions of the sails to be given to two vessels of the same class, can be attended with no inconvenience whatever.

In applying it to the different Frigates which we have been hitherto discussing, the 18-pounder frigate of Baron Sané being taken as the model, we shall find that the surface of the three lower sails, and the

same ratio of the solid, immersed to the circumscribed parallelopiped, their surface of sail, as also their stability, will vary directly as their length.

2nd. That if the only variable quantity is the ratio of the solid immersed to the circumscribed parallelopiped, the surface of sail, and stability, will vary inversely as the displacement.

3d. That if the breadth only varies, the surface of sail and stability will vary as the cube of the breadth.

4th. That if two ships, unequal in capacity, are of exactly the same form; that is to say, if they are constructed on the same plan but to a different scale, the ratio $\frac{L}{h r}$ being then always a constant quantity, the surface of sail and stability will vary as the cube of the breadth, and consequently as the capacity.

All these propositions are exactly in accordance with the principles demonstrated by Bouguer in the *Traité du Navire*, and by Euler in his little work on the *Théorie de la Construction des Vaisseaux*.

Nevertheless, the foregoing formula must only be considered as an approximation; it can only be applied to ships of the same class, and it would be necessary to modify it, if the forms of these ships differed much from the usual form of men of war.

—Author's note.

three topsails* of the latter, being 1,472 sq. met. (15,844 sq. ft.) that of the same sails in the *razèd* ship of the line, or 36-pounder frigate, the GUERRIÈRE might be 2,222 sq. met. (23,917 sq. ft.) instead of 2,158, (23,228 sq. ft.) which has been given her.

For the intended 36-pounder frigate, of 60 cannon and carronades, this surface ought to be 2,252 sq. met. (24,240 sq. ft.) For the intended 30-pounder frigate of 60 cannon and carronades, it ought to be 2,134 sq. met. (22,970 sq. ft.) and for the 24-pounder frigate of 60 cannon and carronades, it ought to be 2,012 sq. met. (21,657 sq. ft.) I would add to these indications, that in establishing the respective dimensions of the lower masts and topmasts, it would be very desirable to contrive them so, that the latter may always be easily shifted at sea; as was lately done at Brest, on board the CLEOPATRA frigate.

* It were useless to include in these calculations any sails but those which are used, either together or separately, when the wind is strong. Besides, the dimensions of the principal masts are regulated by them, and all the other sails are in almost uniform proportion to their size.—Author's Note.

COMPARISON OF THE INTENDED 24-POUNDER
FRIGATE, WITH "LA FORTE," A FORMER FRENCH
FRIGATE OF THE SAME CLASS; AND WITH THE
FRIGATES OF THE AMERICANS.

This is the place to draw some comparisons, which appear to me of high interest to the subject which I am discussing.

France has heretofore possessed frigates armed with 24-pounder guns, and two of these vessels have justly held a high reputation: these were the EGYPTIENNE and the FORTE, built after the plans of Mons. Caro, formerly naval architect at L'Orient. It has often been regretted of late years, that new frigates have not been constructed on the same plan. Admiral Willaumez has made the model of one, in which the details of fitting and rigging are worthy of attention, and have already caused the adoption of several useful alterations in our equipments. But the Admiral, led away by the facility which well-understood arrangements gave him, of contriving on his model large spaces clear for working the guns, has increased the number of the latter, much beyond that which was fixed by the order of the 13th July, 1819.

It is, however, easy to demonstrate, that a frigate such as the *FORTE* could not carry the ordnance which has been given to the *CLORINDE* and the *JEANNE D'ARC*.* Her principal dimensions were as follows :

	m.	c.	ft.	in.
Length	51	97	170	6
Breadth moulded	13	0	42	7 $\frac{7}{8}$
Immersion of the hull, carrying the ports 2 metres out of the water (6 ft. 6 $\frac{3}{4}$ in.)	5	76	18	10 $\frac{3}{4}$
Depth of hold amidships	7	1	23	0

The total displacement of her immersed body was 2,142 tons, which are equal to 2,044 cubic metres.

Supposing even, that the hull weighed only 1,050 tons, (21 less than that of the *CLORINDE*,) or 1,028 metrical tons, equivalent to a displacement of 1,002 cubic metres, there would remain for what was to be carried, a capacity of only 1,042 cubic metres ; and we have seen already, that in the present 24-pounder frigates, 1,246 cubic metres were requisite where there was a weight to be carried of 1,278 metrical tons.

It is true, that this last result is established on the supposition that ten months' provisions and four months' water would be embarked. By reducing the provisions to six months, there would be but 1,122 metrical tons to carry, which would require a capacity of 1,094 cubic metres : there would be, there-

* The *Forte* was constructed to carry only 50 guns, of which 30 were 24-pounders on the main-deck, and 20 were 8-pounders on the upper-deck.—Author's Note.

fore, under this hypothesis, a deficiency of 52 cubit metres in the displacement of the FORTE.

The Americans, whose 24-pounder frigates have served as models for those which England has constructed, have given the following dimensions to the vessels of the same class which they have lately laid down.*

	m.	c.	ft.	in.
Length	53	34	175	00
Breadth moulded	13	72	45	00½
Draught of water above the keel amidships	5	72	18	9½

The product of these three dimensions is 4,186 cubic metres.

These frigates will carry thirty 24-pounder long guns, and thirty-two 32-pounder carronades. Their complement of men will be in all four hundred and twenty-four.

This armament may be, without much error, compared to that of our present 24-pounder frigates; the latter, indeed, have but fifty-eight guns; but our 24-pounder cannon are stronger than those of the Americans, in the proportion of 259 to 240, and our upper-decks are armed with 36-pounder carronades, while theirs have 32-pounder carronades, corresponding to 29 lbs. $\frac{65}{10}$, (*poids de marc.*)

* These dimensions, as well as those of the American ships of the line, which I shall quote hereafter, were communicated to me by M. Marestier, an architect of the Royal Navy, who visited the ports of the United States in 1820, and whose work on the application of steam engines to shipping, is submitted to the judgment of the Academy of Sciences.—Author's Note.

The war complement of the French frigates would also be 460 men; this would be thirty-six men more than that of the American frigates, and the weight of provisions would consequently be much greater.

Hence, in the absence of a full account of what the latter are supplied with, I believe I may consider the total weight of what they have to carry, as nearly equivalent to that of our present 24-pounder frigates; that is to say, about 1,200 metrical tons, which would require a capacity of 1,170 cubic metres.

The three dimensions of the American frigates, forming a cube of 4,186 metres, the volume of their immersed body, supposing it in the proportions we have laid down for the intended 24-pounder frigates (that is to say in the ratio of 0.56 to that of the circumscribing parallelopiped), should be 2,344 cubic metres.

This volume would only be 2,135 cubic metres, in following the proportions of the *CLORINDE*; and it is probable that we shall not be far from the truth in taking the mean term of 2,240 cubic metres.

There will therefore be, as equivalent to the weight of the hull, a displacement of 1,070 cubic metres, corresponding to 1,098 metrical tons.

This quantity exceeds by twenty-three metrical tons, the weight of the hull of the intended 24-pounder frigate, whose mean estimate is 1,075 metrical tons; and this excess will not appear too great, if we consider that the Americans are obliged to make up for the bad quality of most of their oak

timber, by working it up for use with large scantlings.

This, to be sure, is an advantage, viewed with reference to the solidity of the fabric; but it is at the same time a very serious inconvenience, in causing increased massiveness of the vessels.

Upon the whole, it evidently results from what has been above stated, that in augmenting the dimensions which had been established in 1817 for 24-pounder frigates, and above all, in diminishing the difference between the volume of their immersed body and that of the circumscribing parallelopiped, I have only approached, as near as it was necessary to do, to what is practised in the United States.

OBSERVATIONS RELATIVE TO THE SHIPS OF THE
LINE; PROPOSITION TO ESTABLISH TWO NEW
CLASSES.

I PROCEED to what regards the ships of the line. By an order of the 13th of July, 1819, founded on the report of a superior Commission assembled at Paris, the ships of the line of the third class (called seventy-fours), which shall in future be constructed in our ports, are to carry ninety-four guns, of which,

28 are to be long 36-pounders on the lower deck,
30 are to be long 24-pounders on the main deck,
36 36-pounder carronades on the upper deck.

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This armament is heavier than that of our eighty-gun ships, which carry only eighty-six guns, of which

30 are long 36-pounders,
32 are long 24-pounders, and
24 36-pounder carronades, or long 12-pounders.

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It would have been as well to say, that in future we should have no more seventy-four or eighty-gun ships, but only ninety-six-gun ships, which should replace the two present classes of ships of the line, of two decks.

An unanswerable reason ought to induce us to renounce having seventy-four-gun ships of the line. This is, that frigates armed with long 24-pounders, being at present numerous in foreign navies, whenever it happens that the state of the weather will not permit one of these ships to use her lower-deck guns, she will have but the long 18-pounders of her main-deck to oppose to one of the new frigates ; and her safety, as well as the honour of the colours, would be compromised. Now it frequently happens, that owing to their lower tier of guns being carried so low, our seventy-fours are obliged to keep the ports of their 36-pounders closed, especially the lee ones ; and it follows that the most disastrous position for them in engaging a 24-pounder frigate, would be to have the weather gage of her.

But, in proposing a new mode of arming two-decked ships of the line, the Commission appears to me not to have paid sufficient attention to the division of the guns, between the two batteries, and the upper decks of these vessels.

In fact, the armament of ninety-four guns, such as it is proposed to be, being heavier than that of the present eighty-gun ships, it would require, as I shall prove presently, an immersed body which would displace above 4,000 cubic metres of sea water ; and this immersed body could not have less length than that of the eighty-gun ships, without there being an injurious disproportion between this principal dimension and the two others (the breadth

and the depth of immersed body). Now the length of the eighty-gun ships suffices, and more, for placing on each side of the lower deck fifteen long 36-pounders; and it would be a serious fault to reduce the number to only fourteen.

Besides, in fixing the number of carronades to be placed on the upper deck at thirty-six, the Commission has not sufficiently attended to the difficulty which there is, in working the guns abreast the channels. It would be preferable in every respect to place their ports above those of the lower deck, varying only as much as might be necessary for the safety of the shrouds; and consequently their number ought not to exceed more than one at most on each side, that of the main deck guns.

It appears to me, therefore, that the armament of the new ships of the line ought to be as follows:—

On the lower deck	30	long 36-pounders.
On the main deck	32	long 24-pounders.
On the upper deck	34	carronades 36-pounders.
Total		96

This armament will not appear excessive, if we consider that the last ships of the line laid down by the Americans are to carry—

On the lower deck	32	long 32-pounders.
On the main deck	34	ditto ditto
On the upper deck	36	carronades, 32-pounders.
Total		102

It is true, that our 36-pounder cannon and carronades are superior by more than a sixth to the

32-pounders of English calibre ; but the long 24-pounders of the main deck are, on the contrary, weaker by about a fifth, and there results on the whole nearly an exact equality, since the intended French ships of the line will only be stronger in the proportion of 3,072 to 3,024.

It now remains to adjust the weight to be carried by the new ships of the line of ninety-six guns.

The war complement of men of the present ships of the line of the 2nd class, carrying 86 guns, is fixed at 801. The addition of ten carronades on the upper deck, and the somewhat larger dimensions of everything on board, will oblige us to embark twenty-five more men (of which twenty will be for the ten carronades), and which will amount in all to 826.

This ship being intended to hold in future the lowest rate among those which are to fight in the line of battle, will be the class that will be employed to strengthen the squadrons of frigates, which in a time of war will be sent to cruise in the Indian seas, or on the ocean. It will therefore be necessary that she should be able to stow on occasion, as well as those frigates, ten months' provisions, and 120 days' water. But as it is indispensable that the ship, when leaving one of our harbours, should carry her lower ports more than 1 met. 90 cent. (6 ft. $2\frac{7}{8}$ in.) out of the water, I will suppose that she will only retain 2 met. (6 ft. $6\frac{3}{4}$ in.) after having been the first two

months at sea ; that is to say, when she will have no more than eight months' provisions left, the quantity of water on board being always the same, by means of filling the tanks with salt water.

That being understood, the following is a summary estimate of the weight to be carried :—

	met. tons.	E. tons.
Ordnance, with its appurtenances	488	480
Masts, rigging, stores, &c.	360	354
Weight of the crew and their effects	83	81
Provisions, drink, and firing, for 8 months	562	553
Water for 120 days, including weight of tanks	314	309
Provisions for the captain and officers	12	11
Boats and different articles	36	35
Necessary ballast	400	394
<hr/>	<hr/>	<hr/>
Total weight to carry	2255	2221
Supposed weight of the hull	2000	1970
<hr/>	<hr/>	<hr/>
Displacement indispensably necessary for the immersed body	4255	4192
<hr/>	<hr/>	<hr/>
	cub. met.	cub. ft.
Which corresponds to a volume of salt water of	4147	146,459

Our best ships of the line, on two decks, for sailing as well as in every other respect, are the eighty-gun ships of Baron Sané.* The best thing we can do, therefore, is to depart as little as possible from that model, in the new two deckers.

* The only defect which they have been justly reproached with, is, that they do not carry their lower deck ports sufficiently high out of the water ; but it would have been easy to remedy this without hurting their stability, by a slight augmentation of their breadth. Their tumbling home too much above, might be rectified at the same time.—Author's Note.

These are the dimensions of the eighty-gun ship :—

	met. cen.	ft. in.
Length at the water-line	58 47	191 10
Breadth moulded	15 33	50 3½
Depth of immersed body	6 68	21 11
Height of the lower deck ports . .	1 78	5 10
Height of the portsill above the beam .	0 83	2 8½
Depth of the hold	7 63	25 0½
	cub. met.	cub. ft.
Volume of the parallelopiped circumscribing immersed body . . . }	5.987	211,442
Total displacement of the immersed body	3.612	127,565
Ratio of the volume of the immersed body to that of the circumscribing parallelopiped	0.604	

We shall retain this last ratio for the line-of-battle ship of 96 guns ; and her immersed body having a volume of 4,147 cubic metres, it will be found circumscribed in a parallelopiped of 6,866 cubic metres.

In following exactly the proportions of Baron Sané's eighty-gun ship, the principal dimensions of the new ship of the line will be as follows :—

	met. cen.	ft. in.
Length at the water-line	61 20	200 9½
Breadth	16 05	52 8
Depth of immersed body	6 99	22 11½

But in order to have a greater stability while carrying the lower deck ports at a height of 2 metres (6 ft. 6¾ in.) (instead of 1 met. 87 cen. (6ft. 1½ in.) which she would do in proportion to the eighty-gun ship) I think it right to augment the breadth a little at the water-line, and to reduce the depth of the immersed body to 6 met. 95 cent. (22 ft. 9½ in.), the length remaining in round numbers 61 met. (200 ft. 1½ in.)

Thus the dimensions of the new ship of the line of 96 guns may be established as follows:—

	met. cent.	ft. in.
Length at the water-line.	61 00	200 1 $\frac{1}{2}$
Breadth moulded	16 20	53 1 $\frac{1}{2}$
Depth of immersed body	6 95	22 9 $\frac{1}{2}$
Height of the lower deck ports	2 00	6 6 $\frac{1}{2}$
Height of the portsill above the beam	0 83	2 8 $\frac{1}{2}$
Depth of hold amidships	8 12	26 7 $\frac{1}{2}$
Depth of the keel and false keel	0 60	1 11 $\frac{1}{2}$
Total draught of water amidships	7 55	24 9 $\frac{1}{4}$

The surface of the courses and topsails of the eighty gun ship being 2,212 square met. (23,810 sq. feet), that of the same sails in the ninety-six-gun ship ought to be 2,617 sq. met. (28,169 sq. feet) according to the formula before laid down, which is applicable to ships of the line of each rate among each other in the same manner as to frigates.

The new line-of-battle ships of the United States will have dimensions a little smaller, viz.

	m. c.	ft. in.
Length	59 82	196 3 $\frac{1}{2}$
Breadth	16 15	52 11 $\frac{1}{2}$
Depth of immersed body	6 51	21 4 $\frac{1}{4}$

It must be observed, that the Americans have not the same reasons for increasing the scantling of their timber when building ships of the line, as they have in the construction of frigates. Consequently, they keep over us here the advantage of having crews less numerous,* and their provisions have less weight, because they use brandy instead of wine.

* Seven hundred and thirty-two men for the line-of-battle ship of 102 cannon and carronades, 32-pounders.—Author's Note.

Thus, with a fabric of the same scantling, our ships require rather more displacement, for an armament which differs but little.

But in adopting the intended ship of ninety-six guns, we shall still have but an equal vessel to what the Americans are preparing; and it would doubtless appear more worthy of a maritime power like France, not to confine herself always to a tardy imitation of her rivals.

I shall certainly never propose touching the 118-gun ship of Baron Sané, which is acknowledged by all naval men to be the master-piece of naval architecture. All that can be desired is, that attempts may not be made, through an indiscreet zeal, to spoil the ships of that rate, by overloading them with a quantity of guns, stores, and provisions, beyond what is consistent with their capacities.

In 1802, the OCEAN ship of the line, the finest model of that class which ever existed, sailed for America laden with troops, encumbered with military stores and provisions, and brought so low in the water, as hardly to carry her ports at a height of 1 met. 46 cent. (4 ft. 9½ in.) She had lost all her nautical qualities, and the poorest Frigate out-sailed her on every point. This same ship, after having landed the articles with which she was over-loaded, regained her superiority over the other vessels; and beat, by the wind, the INDIVISIBLE, which was then considered one of our best eighty-gun ships.

I mention this fact as a proof of the inconvenience

which follows from changing the original plans of vessels of war, whether with the intention of rendering them stronger by giving them more guns,* or by employing them as transports to carry troops and stores.

In large fleets, three-deck ships of the line have the advantage of overlooking those of inferior rates with the fire of their main and upper decks. Their imposing mass often contributes to ensure victory, solely by the impression of terror which they produce on board the enemy's ships which are not so high.

* Every time that an addition of guns in our ships of the line has been recommended, the demand has been justified by the example of the English, who have been observed to increase successively the number of the guns in their ships of war. The English might in fact do so without inconvenience to themselves. They have harbours and markets always open to them in every part of the world, and the facility with which they can replenish their provisions, renders it unnecessary for them to take on board the quantity that we do. It is also to be observed, that their crews are generally less numerous than ours. It is therefore easy for them to compensate in their vessels, for the surplus weight of a few additional guns.

In the French Navy, on the contrary, we wish to have a greater number of guns, guns of heavier calibre, more numerous crews, and provisions for a longer period of time. This is demanding what is impossible, consistent with keeping the vessels at the same degree of immersion. We must therefore consent to the inevitable reduction of the height of our lower deck ports, with all its disastrous consequences; or, we must build larger vessels.—Author's Note.

It is therefore desirable, that we shall always have a certain number of these ships; but it may be conceived, that an intermediate rate might exist between these and the ships of ninety-six guns.

I suppose, for instance, that the same operation was performed on one of our 118-gun ships, as upon the *ROMULUS*; that is to say, that one of her decks had been taken off. There would have remained a line-of-battle ship of two decks, of very large dimensions, a vast capacity, and whose qualities would, I doubt not, have acquired the same degree of superiority which are observable in those of the *GUERRIÈRE*.

Very well, instead of cutting down a three-decked ship of the line, let us admit that one might be built on two decks of the following dimensions :—

	m.	c.	ft.	in.
Length at the water line	63	34	207	9 $\frac{3}{4}$
Breadth moulded	16	24	53	3 $\frac{3}{8}$
Depth of immersed body amidships	7	30	23	11 $\frac{3}{8}$

The volume of the parallelopiped circumscribing the immersed body, will be 7,509 cubic metres.

According to the proportions which we have hitherto followed, the volume of the immersed body of this ship ought to be to that of the circumscribing parallelopiped, in the ratio of 0,604; it would consequently be of 4,535 cubic metres, corresponding to a weight of sea water equal to 4,653 metrical tons.

This displacement would allow of the vessel being armed with 102 guns, viz.—

32 long 36-pounders on the lower deck,
 34 long 30-pounders on the main deck,
 36 carronades 36-pounders on the upper deck.

Total 102

And her establishment of weight to carry might be the following.

	m. t.	Eng. tons.
Ordnance, and its appurtenances	537	529 11
Masts, rigging, stores, &c.	385	379 34
Weight of crew and their effects, eight hundred and ninety men	89	87 69
Provisions, drink, and firing, for 8 months	605	596 11
Water for 120 days, including tanks	338	333 03
Provisions for captain and officers	16	15 76
Boats and various articles	40	39 41
Ballast	500	492 65
Total weight to carry	2510	2473 10
Remains for weight of the hull	2143	2111 50
Total displacement	4653	4584 60

But it must be observed, that this ship of the line not being like those of ninety-six guns intended to accompany the frigates on distant expeditions, but more particularly, to be employed with fleets and squadrons of the line, it will not be necessary that she should carry more than six or seven months' provisions, when she retains a height of 2 metres (6 ft. 6 $\frac{3}{4}$ in.) for her lower deck ports. Hence the weight to be carried might be diminished by at least 75,000 kilogrammes (73. 9 tons), the weight of one month's provisions, and reduced to 2,435 metrical tons (2,399 tons).

Besides, 2,100 metrical tons would seem to be a

sufficient allowance for the weight of the hull, even in giving it, as well as that of the ninety-six gun ship, a strength of scantling proportionably greater than that of any of our present line-of-battle ships; the weakness of the fabric of the latter being one of the most active causes of the frightful rapidity with which they deteriorate.

It would suffice, then, to have a total displacement of 4,535 metrical tons, 4,468 tons corresponding to a volume of immersed body of 4,420 cubic metres, to be inscribed within a parallelopiped of 7,318 cubic metres.

The dimensions of the ship of the line of one hundred and two guns, might consequently be the following:—

	met. cen.	ft.	in.
Length at the line of floatation	63 00	206	8 $\frac{3}{8}$
Breadth moulded	16 40	53	9 $\frac{3}{8}$
Depth of immersed body amidships	7 08	23	2 $\frac{3}{8}$
Height of lower deck ports	2 00	6	6 $\frac{1}{4}$
Height of the portsill above the beam amidships	0 84	2	9
Depth of hold amidships	8 24	27	0 $\frac{3}{8}$
Depth of the keel and false keel	0 60	1	11 $\frac{3}{8}$
Total draught of water amidships	7 68	25	2 $\frac{3}{8}$

With provisions for eight months, the height of the lower deck ports would still remain 1 met. 92 cent. (6 ft. 3 $\frac{1}{2}$ in.), which would be sufficient in leaving a harbour, and during the first month only, of any cruise whatever.

The surface of the courses and top-sails of this ship ought to be 2,754 square metres, 29,644 square feet.

It cannot be doubted, that with the principal dimensions above established for her immersed body, (and which differ very little from those of a three-decked ship of the line,) it would be possible to give her a form equally advantageous for stability and sailing. In a word, this ship would have over all two-deckers the same superiority which the GUERRIÈRE has over all Frigates.

The 30-pounder calibre of her main deck would render her unassailable by Frigates armed with 24-pounder guns, even under circumstances where there would be too much sea to use her lower deck guns.

Finally, none of the present line-of-battle ships of two decks, of any power whatever, could contend against her, except with a very great inferiority.

ANSWERS TO VARIOUS OBJECTIONS.

THE project of giving increased capacities to our vessels of war, will infallibly meet with opposition.

The principal objections which have already served on similar occasions, to cause the failure of an improvement so loudly called for, are:—

1st, That in giving a ship of the line larger dimensions, especially in length, the solidity of her fabric would be diminished, while her tendency to arch (or become hogged), would be augmented.

2nd, That with timber of a suitable scantling for Frigates armed with cannon of a heavier calibre than 18-pounders, we might construct ships of the line of seventy-four guns; and still more plausibly will it be said, that timber proper for the fabric of the intended line-of-battle ships of ninety-six, and one hundred and two guns, would suffice very well for the construction of first rates of 118 guns.

3rd, That vessels cost so much the more to construct and to equip, in proportion as their dimensions are augmented; and that it would be more economical to have smaller ships.

4th, Lastly, that complements of men, much more numerous, would be required to manage vessels, larger than those which have served us hitherto;

and that consequently, at the breaking out of a war, the resources of the maritime conscription would only admit of our sending to sea a small number of ships of the line, and frigates, of the proposed dimensions.

It is undeniable, that a vessel, of which (the breadth and fulness remaining the same) the length should be suddenly augmented, in order to supply her deficiency of internal capacity, would in consequence be much more disposed to arch (or become hogged); since the excess of weight of each of her extremities above its proper displacement, would act with a much greater momentum in producing immersion. But this inconvenience is not to be equally dreaded in a ship, all of whose parts are proportionally enlarged at the same time; and experience proves, in fact, that eighty-gun ships do not arch sooner, nor in a more sensible manner, than those of seventy-four, though the latter have less length by about 3 met. 50 cent. (11 ft. $5\frac{3}{4}$ in.)

Besides, the calculations on which the dimensions of the intended ships and frigates are established, ensure them such capacities, that in the stowage it will always be possible to find room towards the centre, for the greatest part of the heavy articles they will have to carry. It cannot be doubted, that in keeping out of the extremities, all weight which does not belong to the fabric of the hull itself, except such portions as cannot be detached from it,

(such, for example, as the cutwater and bowsprit forward,) these vessels will have less tendency to arch than those which have not room enough on board to use the same precaution.

Let us add, that their dimensions, relative to the volume of immersed body, will be such, that they may have forward, and aft, much fuller forms than most of our vessels of war have at present; and besides, the weight of the hull of each of them has been established, on a scale sufficiently ample to admit of the scantling of the timber being enlarged, and all the fastenings strengthened, if necessary.

Every thing concurs, therefore, to encourage us, respecting these vessels having a greater tendency to arch than the ships of the line and Frigates, which are at present lying in ordinary in our ports.

The second objection, relative to the timber, is absolutely without foundation.

It is indisputable that the forests of France no longer furnish more than a very small quantity of the large kinds of timber comprehended in the first class of what is used in our dock-yards; and that we must, perhaps, before many years, give up the construction of large vessels of war, or contrive to construct their fabric with pieces of small scantling, making up their want of strength by more skilful arrangement.

But this necessity does not exist for the intended vessels only; it is common to them, with the ships of the line of all rates, which have hitherto com-

posed our fleets. Thus, the remedy which may be proposed for the latter will be equally applicable to the others. If the competition opened in 1820, and upon which a commission is about to decide, should furnish a satisfactory solution of the problem, relative to the best manner of constructing the fabric of a vessel of war in using the least possible quantity of timber of rare dimensions, the difficulty we are now discussing will disappear, whatever may be the system of naval force which may be adopted for the future. The question, then, is reduced to this: Whether, with equal difficulties arising from the scarcity of timber, we should prefer to the present ships of the line, on two decks, which are too much straitened in size, and too feebly armed,—those which are projected, of ninety-six, and one hundred and two guns, whose larger dimensions, and heavier ordnance are more consonant to all the required conditions; and, whether it would not be better to substitute for the 24-pounder Frigates lately constructed and armed at Brest and Cherbourg, which are much too scanty for the purpose, three classes of sixty-gun Frigates, carrying severally on their main decks, thirty long 36, 30, and 24-pounders, giving them at the same time capacities exactly calculated for what they are respectively intended for.

It appears to me that the choice ought not to be doubtful.

As to the assertion, “that with the timber which serves to construct a 24-pounder frigate, a seventy-

four-gun ship might be built," it evidently has no foundation; unless it is supposed that large pieces of timber are wantonly sacrificed to reduce them to the suitable size.

Does this relate to crooked timber for the frame? The regulations admit it of every sort and kind, and of all dimensions, from 22 centimetres of squaring, to 54 and upwards; there is therefore some for all rates and classes of vessels.

Or, is the question concerning straight wood? Without doubt the major part of the planks which are used for a 24-pounder frigate would answer for a 74-gun ship; but it is absolutely the same with those which are worked up for an 18-pounder frigate; only that they furnish a greater number of planks, in proportion as the vessel under construction requires them of a less thickness.

The third objection, founded on the necessity of economy, appears to have been that which has been the most constantly opposed to the adoption of 24-pounder frigates in the French navy, since the *FORTE* and the *EGYPTIENNE* ceased to belong to us.

In 1811, the *CONSTITUTION* American frigate came to Cherbourg. Her armament and equipment were examined and described by a commission, whose report was sent by the Duke Decrès, the minister of marine, to the council of Naval Constructions, with an order to examine it. This council made a report, in which it is said, "that the Ameri-

“can frigate had no other advantage over the *IPHIGENIE*, French frigate of 44 guns, than the superiority of her ordnance; that there appeared to be nothing new about her equipment and rigging;—That this sort of vessel seemed, however, the most proper for cruising on distant expeditions;—That France had possessed the *FORTE*, armed with 24-pounders, a ship which had excellent qualities, but that this species of construction had been abandoned in our ports, out of motives of economy.”

The judgment which the Duke Decrès pronounced in this affair was very remarkable; the following is an extract from it.

“You say that it is economy that has caused 24-pounder frigates to be renounced; this is expressing yourselves in too vague a manner. Do they require the same timber as a ship of the line? If they do not, there is no reasonable economy in reducing to the scantling of an 18-pounder frigate, timber which would merely be not large enough for a line-of-battle ship. Economy of timber is the only one for the consideration of those who have the arrangements of naval building; for, as to the other matters, it is as if you said that there would be economy in putting 18-pounder guns in the place of those of 24. Now to do that, is certainly a smaller expense, but it is not an economy; economy, properly speaking, is that which gives the same results at a less expense; and here the results are different.’

This is, unquestionably, a most judicious refuta-

tion of the system of pretended economy, which has so long caused the rejection of 24-pounder frigates, as more expensive than those of eighteen.

When the decision was come to in 1817, to give the French navy vessels of that class, it was still, however, the fear of incurring too much expense, which caused their dimensions to be reduced in such a manner, that they fulfil but very imperfectly the objects of their armament.

Each of our 24-pounder frigates, at present fitted out, has cost a little less than 1,200,000 francs,*

* This estimate is founded on the abstract made at Brest, of the expense of building and arming the *Jeanne d'Arc*.

This frigate has cost,†

	Francs.	£. ster.
1st, for her hull	524,956	21,873
2nd, for her masts, rigging, and sundry articles of her equipment	423,948	17,664
3d, for her ordnance	223,625	9,317
Total	1,172,529	48,854

	Francs.	£. ster.
A seventy-four gun ship of the line, fully equipped, costs	1,682,000	70,083
An 18-pounder frigate do. do. . . .	865,000	36,041
In proportion to the volumes of the parallelopiped circumscribing their immersed bodies, compared with the seventy-four gun ship, the <i>Jeanne d'Arc</i> should have cost	1,326,000	55,020
And with the forty-four-gun frigate	1,262,000	52,583
Sum	2,588,000	£.107,603

The mean term between the two estimates is Francs. 1,294,000 £.53,801

The *Jeanne d'Arc* was therefore very economically con-

† These sums are calculated at twenty-four francs to the pound sterling Tr.

(£ 50,000 sterling.) With the dimensions of the American frigates, they would probably have come up to 1,300,000 francs, at most (£ 54,125 sterling.)

There has, therefore, been in fact a smaller expense; but most certainly, the result has not been a real economy, since these frigates, such as they are, would be infallibly beaten by those of the Americans, supposing courage, experience, and ability on the part of those who manœuvred them to be on both sides equal. Thus, the honour of the colours would be compromised; and 100,000 francs the more in the coffers of the state, would be but a poor consolation for such a disastrous result.

What came to pass a few years ago, between England and the United States, furnishes a very strong argument in favour of the opinion which I maintain.

The first of these powers possessed an immense number of ships of the line, and frigates, when she went to war with the other. The Lords of the Admiralty would have thought that they were lavish of the finances of the three kingdoms, if they had caused new vessels to be constructed for such an unequal contest; it appeared to them sufficient to construct. For the rest, the objection founded on the supposed use of timber for this class of vessels, which would serve to construct ships of the line, is completely refuted by the above comparison; since, if it had been necessary to make such a sacrifice for the *Jeanne d'Arc*, the waste thereby occasioned would have carried to a much higher scale the expense of constructing the hull of that Frigate.—Author's Note.

set apart for it, some of those with which their ports were crowded.

The Americans, on the contrary, whose naval force at that time was inconsiderable, perfectly understood, that if they confined themselves to building vessels similar to those of the English, they would remain constantly inferior to them ; and with a calculation, the justice of which was proved by the event, they sent to sea frigates respectively stronger than those of their adversaries.

It followed that every time an American frigate met an English frigate alone, the latter was overpowered.

To engage their rivals with advantage, the English were therefore obliged to oppose either two frigates, or a ship of the line, to each of those frigates ; and, according to what I have before explained, the chances of velocity being then in favour of the vessel which was proportionably largest, the American frigate could easily escape the necessity of fighting if she was well manœuvred.

Thus, considered even with reference to the expense, the Americans had made a good speculation, though their frigates had cost more than those of the English, since they compelled the latter to employ two frigates, or a ship of the line, wherever a frigate of the Union could show herself.

The same advantage will always be met with, at least for some time, by the weakest of two maritime powers, when, by the developement of new means,

she can hold the fleets of her rival in check with half the number of vessels.*

If I am now asked where the recommended augmentation in the capacities of our vessels of war, and especially of the ships of the line and frigates, ought to stop, I shall answer, that this limit will always remain subordinate to the extension which foreign navies shall give to the ordnance of their corresponding vessels.

When the English had frigates armed with 18-pounder guns, the French navy was long seen to hesitate in imitating them ; and persisted in having only 12-pounder frigates. We were, however, obliged in the end, to construct 18-pounder frigates, and the main decks of the smallest class of line-of-battle ships no longer appeared to be sufficiently armed with 12-

* On this subject, Admiral Duperré expressed himself after his sojourn in the Chesapeake, in 1819, in the following manner.

“ The Americans calculate by the adoption of their system of building, on compelling the European navies to do away with their present ships of the line (at least those of seventy-four and eighty guns), and to construct new ones. In this case they will have the advantage of priority. This system has already succeeded for them on a small scale. With their large Frigates, which carried thirty 24-pounders on the main-deck, and which had 460 men, they have forced the English, tired of being overpowered in unequal contests, to build only similar Frigates to be employed against them.”

Similar reflections are found in M. Dupin's work upon Great Britain, in the 2nd part “ *Force Navale*,” tome 2, pages 92, 93, 94, et 156.—Author's Note.

pounder guns. From that time ships of the line of 60 and of 64 guns disappeared, and 74-gun ships, carrying 18-pounders on the main deck, were substituted for them.

But, through a fatal continuance of hesitation, these latter vessels, as well as the 80-gun ships, were stinted to having a height for their lower deck ports, which was calculated to be 1 m. 78 c. (5 ft. 10 in.), at most, and which did not, in fact, amount in most of the ships, when they were fully equipped, to more than from 1 m. 72 c. (5 ft. 7 $\frac{3}{4}$ in.), to 1 m. 70 c. (5 ft. 7 in.)

Let us hope, that the experience of the past will not be thrown away upon us ; and that our 24-pounder frigates, at present fitted, or under construction, will be the last trial of a system which it is time to abandon, if we would be promptly prepared to contend with advantage against rival navies.

If we lay down new frigates, they must have sufficient dimensions to engage without inferiority those of England* and the United States ; and it will be

* On this point I may be met with a reference to the published lists of the British Navy, where there appear to be only thirty-six and forty-four-gun Frigates, and ships of the line of 74 or 80 guns among the vessels laid down lately in the Royal dock-yards. But I answer, that the English probably dissemble in this matter, as they did in the accounts of their battles, by leaving the old designations to vessels, whose force of ordnance is much greater than formerly. Do not we ourselves call a ship a "seventy-four," which actually carries eighty-two guns ; and an

contrary to the interests of France to construct henceforward ships of the line whose main-decks may not be sufficient to silence the fire of one of these new frigates.

In the event of the same powers arming larger frigates with long 32-pounder guns (29 lbs. $\frac{65}{100}$ French), we must immediately imitate them, and what is more, construct ships of the line whose main-decks shall be armed with guns of corresponding calibre.

But, what reason is there, that we should wait until we are forced to do this? In all the preparations connected with warlike objects, it is of the highest moment to have the priority of invention, and still more of practice. The results of the hostilities of several years often depend on the moral effect produced by a first success; and it is by taking the lead of the enemy, by multiplying against him new resources, to which he has nothing to oppose immediately—that we succeed in overcoming him.

Without doubt, the ships of 102 and of 96 guns, as well as the sixty-gun frigates of 36, 30, and 24-pounders which I have proposed, will cost much more than our eighty and seventy-four-gun ships, and our forty-four-gun frigates; but these vessels having better qualities, sailing better, and being

“eighty gun ship,” one that carries eighty-six?” (See the “*Voyage dans la Grande Bretagne*,” par M. Dupin, 2 partie, “*Force Navale*,” tome 2, pages 89 et suivantes.—Author’s Note.

better armed, the Royal Navy will be stronger. It will sustain with more probability of success, the rights of France, and the honour of the King's colours. It may calculate on gaining victories, while in the present state of the vessels, it has to expect defeats. In a word, in the one case the expense will be profitable, while in the other, it will prove to be detrimental. There will, therefore, be a real economy in following the proposed system ; since the chances of advantage arising from it, increase in a much greater proportion, than the sacrifices which it will be necessary to make for obtaining them.

The objection relative to the insufficiency of the number of seamen on the " maritime inscription," does not apply more to one system of naval force than another. If, for instance, it were found to be necessary to oppose to the enemy 30,000 sailors, and the registers could only supply 20,000, there would result a deficiency of one-third, whatever might be the sort of warfare decided on ; and it would be necessary to take steps for supplying it.

A simple question, therefore, presents itself for solution, which is this —

" If twenty thousand men only are disposable for manning the Royal Navy, what would be the best manner of employing them ?"

At the time, when a flotilla of eighteen hundred vessels was assembled on the coasts of the channel for the purpose of invading England, the following

argument was often heard. "An 18-pounder Frigate carries forty-four guns, and three hundred and twenty-five men. Fifteen gun-boats, carry forty-five guns of heavier calibre (24-pounders), and four hundred and fifty men, therefore they ought to capture an 18-pounder Frigate."

But, in order to take a vessel, it is necessary to come up with her; and that is what the gun-boats could not have done, except in the case of a dead calm, which is excessively rare, or when the Frigate was at anchor; in this latter situation, she would find abundant means to prevent boarding, and to throw her assailants into disorder.

Thus the argument in favour of the gun-boats was not founded in fact, and four hundred and fifty men distributed among fifteen of those vessels would not have added so much to the real force of the Navy as three hundred and twenty-five men united on board a single Frigate.

It is equally easy to perceive, that ten 18-pounder Frigates, manned by 3250 men, would not render near the same service as seven 24-pounder Frigates manœuvred by 3220 men.

The seven 24-pounder Frigates would present on each side 105 long guns, and as many carronades; while the ten 18-pounder Frigates could oppose to them only 140 long guns, and eighty 24-pounder carronades; ordnance of which the respective strength is in the ratio of 25 to 22 nearly.

If we add to this first cause of superiority, the

advantages which result from a stronger scantling—a capacity large enough to carry ten months' provisions—the great probability of better sailing—and the possession of greater size in the event of boarding—there will remain no uncertainty as to the preference which should be given to the seven 24-pounder Frigates over the ten 18-pounder Frigates.

The same observations will equally apply to the intended ships of the line, compared with those of eighty and of seventy-four-guns, which we now possess.

Let us remark besides, that if with a view to the employment of fewer men, we persist in having only ships of the line of the latter rates, while rival navies send to sea ships of ninety-six, and a hundred and two guns, we must either be always overpowered where the number of ships is equal, or, we must oppose a line of battle ship, and a frigate, at least, to each of the enemy's ships of the line.

There would be in this arrangement neither economy of men, since 996 would be required, instead of 826 ; nor economy of money, since a seventy-four-gun ship, and an 18-pounder Frigate, cost together much more than one of the new ninety-six-gun ships would.

I think it superfluous to extend this argument farther. It seems to me proved to demonstration, that it will be always more advantageous to employ the number of seamen which may be disposable, in a small number of vessels, mounting heavy ordnance,

and possessing superior qualities, to dividing them among a greater number of vessels, which the progress of foreign navies has reduced to be no longer in a condition to assert, as it ought to be done, the honour of their colours.

ARRANGEMENTS WHICH IT WILL BE NECESSARY
TO MAKE WITH RESPECT TO THE SHIPS OF
THE LINE AND FRIGATES, WHICH WE AT PRE-
SENT POSSESS.

A VERY important question remains to be solved, which is this :

“ In case the proposed ships of the line of 102, and of 96 guns, as also the frigates armed with 36, 30, and 24-pounder cannon, shall be adopted, must we consider as useless, all the shipping of the navy which we already possess ?”

No, doubtless ; it would be impossible to justify such a decision. By means of the repairs, constructions, and rebuilding, which have for several years been going on in our great arsenals, the Royal Navy would be enabled to make an honourable display, if it were suddenly required to fit-out for war ; and I have never thought that it would be suitable to disarm our ships altogether, under the pretext of preparing them with better armaments for a future contest.

The line of battle ships and frigates, which we have at present, are deficient in capacity and height for their ports, because the weight which they have to carry has been augmented beyond what was fore-

seen or intended, by their original plans and establishment. But, these vessels have to a very high degree every other nautical quality ; and in order to turn them to the best possible account, all that is necessary is, to regulate properly the total weight which they have to carry, and to get rid of the incumbrances which overload them.

Let us examine them one after the other in the order of gradation.

The sole modification which is desirable in the Baron Sané's 118-gun ships, is, that their guns should be reduced to their original number, which has been already far too much exceeded.* It is farther necessary, to be careful that they shall never be overloaded with passengers and stores, in order to retain for them a sufficient height for their ports. It would also be easy to diminish a little the tumbling home of the topsides, when new ships of this sort are built, and then they would be the best vessels of the kind that could be desired.

These ships ought not to be employed, except in

* It would be to spoil these ships to give them, instead of quarter-deck and forecastle guns, a continuous fourth battery on the upper deck, so as to have 130 guns. To consent to this addition of weight above, without changing anything in the principal dimensions, and the volume of immersed body, would be to expose ourselves to the risk of having nothing but vessels without capacities proportioned to the weight which they would have to carry, and which would be found immersed several centimetres beyond the line of floatation determined on by the constructor.—Author's note.

squadrons, which should not be intended for very long cruises, but which should be more particularly appropriated for the protection of our colonial establishments, as well as for the defence of the roads and anchorages in the vicinity of our ports, against the enemy's cruisers, which might attempt to impede the arrival of our convoys and light squadrons.

To perform a service of this sort, it is altogether useless to embark more than five months' provisions, and three months' and a half water. The present establishment supposes six months' provisions and four month's water ; it is, therefore, possible to effect a reduction of one months' provisions and of half a month's water, weighing together 142,000 kilogrammes (140 tons), of which the total weight of the vessel being relieved, the height of her ports would be augmented by 16 centimetres ($6\frac{1}{4}$ in.), and would amount to 1 m. 82 c. (5 ft. $11\frac{5}{8}$ in.), which would in strictness suffice for fighting. In case of need, even a sixth months' provisions might be embarked, since, after only one month's cruise, the height of the ports would again be brought to 1 metre 82 centimetres (5 ft. $11\frac{5}{8}$ in.)*

The eighty-gun ship has a height of only 1 met. 78 cents. (5 ft. 10 in.) for her ports, while it is necessary that she should have at least 1 met. 95 cents.

* I have nothing to say about the ships of 110 guns, a bastard and completely useless rate. We only possess two, and there can be no intention of building more.—Author's note.

(6 ft. $4\frac{3}{4}$ in.), consequently, she must be overloaded to the amount of 135,000 kilogrammes, (133 tons.) It would be difficult to effect so considerable a diminution on the weight which this ship has to carry without reducing the quantity of provisions and water necessary for a cruise. But 30-pounder guns might be substituted for the 36-pounders of her lower deck, and 30-pounder carronades for those of 36 on her quarter deck and forecastle. The complement of men might be fixed at 780 instead of 801, because of the diminished calibre of the lower and upper-deck guns; and lastly, the ballast might be lightened by 20 or 30,000 kilogrammes, to balance the reduction effected in the weight of the guns.

There would result from these alterations,—

	m.t.	Eng. tons
1st, on the weight of the ordnance, and its appurtenances, a diminution of	40	39.41
2nd, on the weight of the crews and their effects (21 men less)	2	1.97
3d, on the provisions, calculated at six months, for 780 men, instead of 801	11	10.83
4th, on the water, for 120 days, for 780 men, instead of 801	8	7.88
5th, on the ballast, a possible diminution	20	19.71
Total	81	79.80

Which is less than the necessary reduction by 54,000 kilogrammes, ($53\frac{1}{4}$ tons;) so that this ship, on leaving a harbour with six months provisions and four months water, would only have 1 met. 88 cents. (6ft. 2 in.) height for her ports; but after being twenty-four days at sea, she would be lightened of 55,000 kilogrammes by the consumption of provisions and

water, and would then carry her ports at a height of 1 met. 95 cents. (6 ft. $4\frac{3}{4}$ in.)

It would therefore appear to be desirable to adopt the proposed modifications.

It must be observed, besides, that this ship carrying her guns higher out of the water, would be found sufficiently balanced by the lower stowage of the weight of the water in the hold, which has been much more advantageously placed for stability, since it has been contained in rectangular iron tanks.

As to the seventy-four-gun ships, the height of their ports is reduced to 1 met. 73 cents. (5 ft. 8 in. ;) they consequently want an addition of 22 cents. at least, which corresponds to an excess of weight of 157,000 kilogrammes, ($154\frac{7}{10}$ tons.) To effect so great a diminution, we must,—

1st, Reduce the guns to twenty-eight 30-pounders, on the lower deck ; thirty 18-pounders on the main deck, and twenty-four 30-pounder carronades on the upper deck. The total weight of the ordnance, with its appurtenances, and ammunition of all sorts, would thus be 358,000 kilogrammes, instead of 378,000 kilogrammes, which the present ordnance weighs.

	m. t.	Eng. tons.
This would be a diminution of	20	19.71
2nd. Discharge twenty-six men, because of the diminished weight of the guns	3	2.96
3rd. Embark no more than five months' provisions, and three months' water, for a complement of 645 men, instead of for 671 men ; reduction of	139	136.95
Total	162	159.62

A sixth month of provisions would reduce the height of the ports to 1 met. 88 cents. (6 ft. 2 in.) which might in strictness suffice for the beginning of a cruise; and after the consumption of twenty-five days, this height would be brought back to 1 met. 25 cents. (6 ft. $4\frac{3}{4}$ in.)

Thus, in renouncing henceforward the construction of seventy-four gun ships of the line, the best use to make of those which we possess already, whether afloat or on the stocks, will be to arm such as are in good condition with twenty-eight 30-pounder guns, thirty 18-pounders, and twenty-four 30-pounder carronades, giving them a complement of 645 men; and to convert into 36-pounder Frigates, like the *GUERRIÈRE*, such as stand in need of thorough repair.

I return to the 24-pounder Frigates which have recently sailed, or which are still upon the stocks.

All the reports agree in describing them as very fine vessels, which look remarkably well on the water, but which are deficient of 22 centimetres ($8\frac{5}{8}$ in.) height for their ports, notwithstanding the 54 millimetres ($2\frac{1}{8}$ in.) of fulness which was given to them more than was intended in the original plans.

This excess of immersion corresponds to an overweight of about 128,000 kilogrammes, ($126\frac{1}{8}$ tons) which must be removed, in order to render these vessels as serviceable as they are capable of being. The way to effect this would be to reduce their ordnance to fifty guns, of which thirty should be

long 24-pounders, and 20 carronades of the same calibre.*

Their complement of men ought then to be only 440, and the scale of the weight which they would have to carry would be established as follows:—

	m. t.	Eng. tons.
Ordnance, its appurtenances and ammunition	203	200.1
Masts, rigging, and stores	190	187.21
Crew and their effects	44	43.35
Provisions, drink, &c. for six months	224	220.71
Water for 120 days, including the tanks	167	164.55
Provisions for the captain and officers	6	5.91
Boats and sundry articles	18	17.73
Ballast	200	197.6
	<hr/>	<hr/>
	1052	1036.53
Weight of the hull, (that of the <i>Clorinde</i>)	1048	1032.59
	<hr/>	<hr/>
Total weight	2100	2069.12

* When the *Amazon* was fitting out at Brest, the Baron Roussin, who was appointed captain of that Frigate, expressly demanded the substitution of 24-pounder carronades for those of 36 pounds, which were to be placed on her quarter deck and forecastle.

M. Simon, the Naval Architect, upon whose plan that Frigate and the *Jeanne d'Arc* had been constructed, had before proposed the same thing. I have already had occasion to quote a similar opinion expressed at Cherbourg by a commission, which included M. Bretocq, the Naval Architect who had planned the *Clorinde*. The necessity of diminishing the weight which these Frigates had to carry, has therefore been acknowledged on all hands.

But in doing no more than substituting twenty-eight 24-pounder carronades, for an equal number of 36-pounders, the weight to carry would in fact only have been reduced by 24,000 kilogrammes, while the excess amounts to 128,000 kilo-

According to the regulation of the 12th May, 1817, the Frigates in question, ought to have as a *maximum* of displacement, 2056 metrical tons, ($2025\frac{3}{4}$ tons;) but as their fulness was augmented by 54 millimetres, ($2\frac{1}{8}$ in.) after they were laid down, their real displacement with the ports at 1 met. 95 cents. (6 ft. $4\frac{3}{4}$ in.) out of the water, is 2088 metrical tons, ($2057\frac{1}{4}$ tons,) which is only 12,000 kilogrammes ($11\frac{8}{10}$ tons) less than the weight now proposed to be carried; and it would be easy to balance this light overweight, by taking out an equal quantity of ballast, because of the diminished weight of the guns.

Perhaps, it will be difficult to obtain the reduction to ten carronades on each side, of the number on board these vessels, because their upper-deck being very wide, and flush fore and aft, affords the finest accommodation for a continuous battery, and there will remain large spaces void, the sight of which will be a daily subject of regret.

If this should be the case, there would be another manner of arming these Frigates suitably, and which would consist in giving them,

30 carronades, 36-pounders, on the main deck,	
28 carronades, 36-pounders, }	on the quarter deck and
2 long guns, 24-pounders, }	forecastle.

60

grammes. We must therefore go farther, and limit their ordnance to fifty guns in all, in order to be able to diminish the complement by at least twenty men.—Author's Note.

It would perhaps be proper to make a trial of this, upon one of those which are still upon the stocks.

Under this hypothesis, the establishment of what they would have to carry would be the following:—viz.

	Metrical tons.	
Ordnance, its appurtenances and ammunition	214	
Masts, rigging, and stores	190	
Crew and their effects, 350 men	35	
Provisions and firing, for ten months	297	
Water for 120 days, including the tanks	133	
Provisions for the captain and officers	6	
Boats and divers articles	18	
Ballast. (N.B. The diminished weight of the guns admits of this being much reduced)	150	English tons.
	<hr/> 1043	1027.67
Weight of the hull	1048	1032.59
Total	<hr/> 2091	<hr/> 2060.26

Now, we have just seen that the displacement of these Frigates is 2088 metrical tons, ($2057\frac{1}{4}$ tons) owing to their fulness having been augmented by 54 millimetres ($2\frac{1}{8}$ in.), they would therefore have with the armament now proposed, a height for their ports, of very nearly 1 met. 95 cent. (6 ft. $4\frac{3}{4}$ in.) and the subsistence of their crews would be ensured for ten months.

It will doubtless be objected to this plan of armament, that the range of 36-pounder carronades is so

much shorter than that of long 24-pounders ; it will be said that a Frigate thus armed might be fought at a distance, with the advantage too much in favour of another which should have long guns on the main deck. This objection would be very strong, if it were admitted that the Frigate armed with carronades, had a very decisive inferiority of sailing to the one which attacked her ; but if she sailed better, or equally well, it would be easy for her to manœuvre, so as to keep her opponent well within the range of her 36-pounder carronades. This is the way in which almost all actions are fought at present, between vessels which are not obliged to keep in line.

Now, it would be difficult to believe, that Frigates such as the JEANNE D'ARC, AMAZONE, and CLORINDE, which already sail tolerably well, notwithstanding the over-weight of 128 metrical tons ($126\frac{1}{10}$ tons) which they have to carry, would not acquire superior velocity, when by getting rid of that excess of weight, they should be brought back to those lines which were intended by the naval architects who planned them, as being most favourable to their sailing and stability.

Immediately after the present 24-pounder Frigates, come the forty-four gun Frigates, carrying twenty-eight 18-pounders on the main deck.

These Frigates are, in general, excellent vessels ;*

* Independent of the Baron Sané's forty-four gun Frigates, there are in the Royal Navy, several constructed by M. Rol-

the only objection which can with some appearance of reason be made to them is, the excess of their tumbling home above; a defect which it would be very easy to avoid in those which may be constructed in future.

These Frigates might also be armed with 36-pounder carronades, twenty-eight on the main deck, and twenty on the quarter deck and forecastle, to which might without inconvenience be added two long 18-pounders for chase guns on the forecastle. A crew of three hundred men would then suffice, and the total weight which they would have to carry, with six months' provisions, and four months' water on board, would be 10 metrical tons ($9\frac{7}{8}$ tons) less than with the present armament. These vessels would thus fill very advantageously the interval which separates the new 24-pounder Frigates from the flush-decked Corvettes which should be armed with 24-pounder carronades.

The presents Corvettes, called twenty-gun ships, and which have quarter decks and forecastles, can only possess in a very moderate degree the qualities essential at sea. Their upper works are always too lofty in proportion to their length, and their draught of water; and this single disproportion renders it impossible to give them any superiority in sailing or manœuvring.

land, Inspector General of Naval Engineers, and by M. Pestel, Sub-director of Naval Constructions. They are all remarkable for excellent qualities. — Author's Note.

It appears to me, therefore, desirable that we should renounce entirely having Corvettes with quarter-decks and forecastles, and have nothing below forty-four gun Frigates, (henceforth to be armed with 36-pounder carronades,) except flush Corvettes.

Two classes of these latter vessels might be adopted ; the one with the dimensions of our present twenty gun Corvettes, and the other similar to the *DILIGENTE*, constructed by the late M. Ozanne. This one, is unquestionably the best model to follow in constructing vessels for sailing ; but she too, would be spoiled, if she were burthened with a weight of ordnance, beyond what was originally contemplated.

The flush Corvettes of both classes, would have a much lighter draught of water than the Frigates, and consequently might be very usefully employed in the pursuit of convoys which should seek shelter near the land ; it would even be desirable on this account, that one should always accompany the squadrons of Frigates, sent on distant cruises during a war.

The naval transports, are very good vessels for the purpose they were intended for ; they would be among the worst, from the day that it should be attempted to give them heavier ordnance than their original armament, with a view to making them vessels of war.

Our Brigs have but very moderate qualities ; because, notwithstanding the example of the English, we have always taken pains to cramp their dimen-

sions unreasonably. It can only be by lengthening those which may henceforth be built in our dock-yards, and giving them sufficient breadth to ensure their stability, that we can hope to see them good sailers.*

We shall probably find the Brigantines imitated from those of the Americans of very great utility, as also such as the *GAZELLE*, constructed at Bayonne, after a draught proposed by M. Marestier; but this must always be subject to the condition of not overloading them with guns, men, and provisions. Small vessels, suffer still more than large, by the submersion of the line of floatation which is designed for them in the original plans; and care should be taken never to overload them beyond the weight which was intended in the scale on which the dimensions of their immersed bodies were calculated. As for the smaller schooners, which are meant to act as advice-boats, it will be necessary, in order to ensure them a suitable velocity, to give them very fine forms, and to build them of a much slighter fabric than it has been customary to do; consequently their ordnance cannot be too light.

But it is difficult to reconcile this last condition, with the necessity of being prepared to resist the insults of the numerous privateers which infest

* The Brigs recently laid down at Toulon partly fulfil these conditions; their length is greater than that of our present Brigs of sixteen carronades; but their breadth appears to me to be still far too little.—Author's Note.

every sea, under the pretext afforded by the political state of South America.

It would therefore be desirable to examine in the first place, whether, while this state of hostilities exists, it would not be more prudent to employ as advice-boats, Corvettes only, such as the *DILIGENTE*, or at least similar Brigantines to the *GAZELLE*.

OBSERVATIONS ON OUR SYSTEM OF SEA ORD- NANCE.

IN all that I have hitherto said, I have gone upon the supposition that no other change would be made in our system as to the guns, than the introduction of the 30-pounder cannon, and carronades, which would be cast this year, after the models prepared in 1821, according to the instructions given by Lieutenant General Thirion, the Inspector-General of Naval Artillery.

This innovation is already a very important improvement; but it is not the only one, which the armament of our vessels requires.

The 36-pounder cannon, which are a great deal too heavy, wear excessively the decks of our ships of the line. They require a great number of men to work them, and if they have over guns of inferior calibre, the advantage of dealing heavier blows because of the larger size of their shot, this superiority is overbalanced by a less rapid fire, which in a given time, discharges no more weight of iron than a long 24-pounder.

It would, therefore, appear, that 30-pounder guns which are much more easy to work, ought to be substituted for those of 36 on board our ships of

the line,* and this arrangement would render our arms only equal to those of the English and American navies.

But if we are unwilling to forego the superiority of calibre, we should at least endeavour to diminish the weight of the 36-pounder cannon.

Col. Paixhans, of the Royal Artillery, published in the beginning of the year 1821, a work entitled "*Nouveau moyen de force Maritime*," in which he renewed the proposition of adopting for the armament of ships of the line, short 36-pounder cannon, of an intermediate weight, between the long guns and the carronades of that calibre, at present used in the Royal Navy.

* It is to the weight of our guns that we must impute the little benefit that we have always derived from the English line of battle ships, which the fortune of war has placed in our power. The 32-pounder guns (29 lbs. $\frac{65}{100}$ French), were taken out to make room for those of 36. Heavier ammunition was required, a more numerous crew, and consequently also, more provisions and water. From thence ensued an overweight of some hundreds of tons, which sufficed to annihilate all the nautical qualities of the vessel.

The contrary took place when the English re-armed a ship of the line of our construction. Lighter ordnance, a reduced crew, provisions in smaller quantity, and from thence a total weight much less considerable, which raised the height of the ports to two metres (6 ft. $6\frac{3}{4}$ in.), and favoured the sailing by lessening the draft of water by from 20 to 25 centimetres ($7\frac{7}{8}$ in. to $9\frac{7}{8}$ in.). This observation, the accuracy of which is incontestable, completely corroborates the principles developed in this memoir.—Author's note.

The system of this reduced ordnance, which has long been indicated in the writings of several French naval and artillery officers, has lately been tried in England by General Congreve. Very interesting details on the subject are given in the second part of M. Dupin's works. That engineer himself has, in his sketch of naval architecture, presented to the Institute in 1815, clearly shown the advantages of a unity of calibre on board of each vessel.

But M. Paixhans goes farther, and proposes to have henceforth a single calibre only (that of 36), for the ordnance of our ships of war of all rates, from a three-decker, to a schooner.

This measure, however inviting it may appear at the first view, would be attended with very great inconvenience. The most important would be that, of having no other gun of a long range, than the present 36-pounder, which is excessively difficult to move, and whose weight, the lower-deck of a ship of the line is hardly strong enough to support. Frigates could only be armed with guns which would differ very little in range, and uncertainty of fire, from carronades.

Independently of this consideration, there is another, to which M. Paixhans has not attended, and which would render impossible in our vessels, (such as they now are,) the substitution of 36-pounder cannon for those of 24, or 18-pounds. The weight of the guns and of their carriages would, to be sure,

remain the same ; but that of the supply of shot would be so much greater, that the total weight which the vessel would have to carry, would be necessarily increased. I therefore do not think that it would be prudent to entertain the project in question. But in applying the proposed measure to the 36, 30, and 24-pound calibres, the navy would be provided with suitable guns for all classes of vessels, and it would become possible to do away entirely with inferior calibres.

The following is the manner in which I conceive guns might be classed under a new arrangement of our system of naval ordnance.

1st. The present long 36-pounder guns should be abolished, and there should be substituted for them, guns of the same calibre, a little shorter, weighing 180 times the weight of their shot, that is to say, one tenth less than those we now have.

2d. The second class should be other 36-pounder guns, still shorter, and weighing 160 times the weight of their shot.

3d. Then would follow 30-pounder guns, such as will be cast in the course of this year in the founderies of the navy, and which are intermediate between the present 36 and 24-pounders.

4th. The short 30-pounders, weighing 160 times the weight of their shot.*

* Lieutenant-General Thirion, anxious to further all the improvements that can be desired on this head, has caused a short

5th. The present 24-pounders would compose the fifth class.

6th. Short 24-pounders weighing 160 times the weight of their shot, should replace the long 18-pounders.

7th. The present 36, 30, and 24-pounder carronades, should be the only pieces inferior to the short 24-pounder guns. *

If cannon of these different kinds existed at pre-

30-pounder gun to be cast, which will only weigh from 2,600 to 2,700 kilogrammes (51 cwt. 0 qrs. 26 lbs., to 53 cwt. 0 qrs. 23 lbs.)

(See the appendix at the end of this memoir.)—Author's note.

* The respective weights of these pieces, with their carriages and all the stores and ammunition appertaining to them, may be estimated nearly as follows.

	kgmms.	cwt.	qrs.	lbs.
1st. Long 36-pounder cannon, reduced to the weight of only a hundred and eighty times that of its shot	6470	127	3	12
2nd. Short 36-pounder cannon, weighing 160 times as much as its shot	6000	118	0	26
3d. Long 30-pounder cannon, intermediate between the present 36, and 24-pounders	5980	117	3	10
4th. Short 30-pounder cannon, weighing 160 times the shot	5200	102	1	24
5th. Long 24-pounder cannon	5000	98	2	3
6th. Short 24-pounders, weighing 160 times the shot	4230	83	1	11
7th. 36-pounder carronade	3520	69	1	12
30-pounder do.	3090	60	3	15
24-pounder do.	2660	52	1	18

These data ought not to be considered as rigorously exact, but they will suffice to calculate very nearly, the weight which the vessels will have to carry, according to the guns which may be put on board of them.—Author's Note.

sent in our Arsenals, the following is the manner in which I should propose arming the vessels of all rates which have been considered in the course of the preceding discussions.

The three-decked ship of the line might carry,

On the lower deck	32 long 30-pounders.
On the middle deck	34 short 30-pounders.
On the main deck	34 carronades 30-pounders.
Quarter deck and forecastle	20 carronades 30-pounders.

120

The total weight of these guns with their stores and ammunition, would be only 535,000 kilogrammes, while that of the present ordnance of the same ship amounts to 555,000 kilogrammes. There would therefore be in addition to the advantage of unity of calibre, that of a diminution of twenty metrical tons in the weight to carry ; the height of the ports would be increased by more than 2 centimetres, (about $\frac{3}{4}$ in.) and the stability of the ship would be much improved by this new armament.

The intended ship of 102 guns should receive,

On the lower deck	32 long 36 pounders, (new.)
On the main deck	34 short 36 pounders.
Quarter deck and forecastle	36 carronades, 36-pounders.

102

The weight of this ordnance, with all its accessories, would be only 538,000 kilogrammes, and that which I first proposed to give this ship, composed of the guns at present in use, would weigh 553,000

kilogrammes, although there were to be only 30-pounder guns on the main deck. There would therefore be, besides the advantage of having a single calibre for the whole armament, that of having fifteen metrical tons less weight to carry.

The intended ship of 96-guns, should carry,

On the lower deck	30 long 36-pounders (new.)
On the main deck	32 long 30 pounders.
Quarter deck and forecastle	34 carronades 30-pounders.

96

This ordnance would have a total weight of 490,000 kilogrammes, instead of 488,000 kilogrammes, which had been intended in the previous plan of armament. Only two metrical tons more.

The 80-gun ship of the line might be armed

On the lower deck, with	30 long 30-pounders.
On the main deck with	32 short 30-pounders.
Quarter deck and forecastle with	24 carronades 30-pounders.

86

It is true that the total weight which this ship would have to carry, would then be six tons more than with the armament which I have previously proposed for her, because each of the short 30-pounders of the main deck, would weigh, with its ammunition and stores, 200 kilogrammes more than the long 24-pounder guns. But this increase of weight being owing only in a great measure to the enlarged diameter of the projectiles stowed in the

hold, it would be easy to compensate for it sufficiently by taking out an equal quantity of ballast.

The armament of the 74-gun ship might be,

On the lower deck	28 long 24-pounders.
On the main deck	30 short 24-pounders.
Quarter deck and forecastle	24 carronades 24-pounders.

82

The total weight of this armament would be only 331,000 kilogrammes, instead of 358,000 kilogrammes, which the one I before recommended would have weighed. There would consequently be a saving of twenty-seven metrical tons, equivalent to half a month's provisions.

The intended 36-pounder Frigate should carry,

On the main deck	30 long 36 pounds.
On the upper deck	32 carronades 36 pounds.

62

These sixty-two guns would have a total weight of only 307,000 kilogrammes, instead of 314,000 kilogrammes, which would result from the armament fixed at sixty guns, with the present 36-pounders.

The intended 30-pounder Frigate should have

On the main deck	30 short 30 pounds.
On the upper deck	32 carronades 30-pounders.

62

There would result a weight to carry of 255,000 kilogrammes, which would be less by 17,000 kilogrammes than the armament first proposed.

The intended 24-pounder Frigate might receive

On the main deck	30	short 24-pounders
On the upper deck	32	carronades 30-pounders.*
<hr/>		
62		

This ordnance would weigh in all, with its stores and ammunition, 227,000 kilogrammes, while the first armament proposed of thirty long 24-pounders, and thirty 24-pounder carronades, would have a weight of 230,000 kilogrammes.

Lastly the Frigates such as the CLORINDE, AMAZONE, &c. might retain fifty-eight guns, if they were fitted with,

On the main deck	30	short 24-pounders
On the upper deck	28	carronades 24-pounders
<hr/>		
58		

The 18-pounder Frigates only, should then be armed with 36-pounder carronades on both decks.

This sketch appears to me sufficient, to prove what immense advantages our navy would derive from the proposed changes; it is therefore highly desirable that they should be effected without delay.

I do not however deceive myself with supposing that a decision of this nature must not meet with great opposition. It will be above all objected, that

* By this new manner of arming the intended Frigates, those of 24-pounders on the main deck would lose the advantage of having only one calibre on board; but as the vessels of this kind are more particularly intended to fight near, and to attempt boarding, it will always be desirable to give them guns on the upper deck which may discharge at each round the greatest possible quantity of grape shot.—Author's note.

the Royal Navy possesses a considerable number of 36, 18, and 12-pounder guns, &c. which will thus be excluded from our armaments, and which it will be necessary to recast, with the addition of the requisite metal, thereby giving rise to an enormous expense.

This is a real difficulty ; but it does not appear to me sufficient to cause the rejection of a manifest improvement. On the contrary, it ought to be a motive for hastening the resolutions which should be taken on this subject. For, by successively applying to this purpose a proportion of the sums annually devoted to the service of the Navy, we might acquire, in the space of a few years, a sufficient number of guns of the new dimensions to arm all our ships. Until this can be done, they should be supplied with the ordnance which we already have in our arsenals.

Let it be farther observed, that it is not proposed to recast the whole of the cannon, as it would be necessary to do, if it were intended to change the calibres hitherto used. The present long guns of 30 and 24 lbs. and the 36, 30, and 24-pounder carronades will remain ; and the shot of those calibres with which our parks are stored, will serve for the short new guns, as they did for the old.

OBSERVATIONS ON THE METHOD USED FOR FITTING CARRONADES ON BOARD VESSELS OF WAR.

THE question relative to the classification of the guns, is not the only one to be considered, relative to the service of the ordnance on board vessels of war. It would be also a very interesting subject to examine whether we ought to persist, or not, in fitting according to the established usage, the carronades on the upper deck, with fixed breechings.

The advantages of this method are, having carriages less heavy and cumbersome—fewer men employed to work each gun—and the discharge of a greater number of rounds in a given time.

But these appear to be far outweighed by the inconveniences, which are as follow :—

It is necessary to give to the ports when carronades are fitted with fixed breechings, enormous dimensions, which sensibly diminish the shelter afforded by the bulwarks, to the men on the upper deck. These bulwarks, weakened by such large openings, are additionally shaken at each discharge, by the strain of the carronade on its breeching. The loader is obliged to stretch himself almost entirely out of the port, to put in the charge and to use the sponge. While these operations are going on, he is exposed

to the fire of the enemy, and if the distance is small, he becomes a mark for the musketry of the upper deck, and tops. However brave we may suppose a man in such a situation to be, it is impossible but that he must hasten to be out of it; and in the hurry with which he acts, it is probable that the grape or round shot, which ought to go into the piece, is dropped overboard, without the circumstance being known inside the vessel. This accident would be the more frequent, in proportion as the calibre of the carronades is larger; because the charge is from its weight, more difficult to hold.

If in fact it happens, as I have been assured by many Naval Officers, that nearly half the discharges of carronades are with powder only, when an action is fought close, it would doubtless be preferable, that they should be worked with less rapidity, and be fitted with long breechings. It is said that the majority of English Captains have returned to the practice of doing so.

I shall not pursue these reflections farther. They suffice to show all the interest of the question, and the necessity of fixing the still unsettled opinions of naval men on this subject.

CONCLUSION.

IN commencing this Memoir, it was not my intention to extend it so far. But according as important questions came under discussion, they suggested developments which I thought I could not omit, because they furnished me with arguments more and more strong, in proof of the necessity of modifying the system of our naval force. On such a subject, conviction can only be produced by the comparison of a great number of facts. It was incumbent on me to multiply the proofs every time that I had to contend against opinions, long established in our navy, where they derive great strength, from the reputation of those who hold them.

Throughout this long series of arguments and calculations, I have abstained from all discussion which related to the purely theoretic part of naval architecture.* My object was not to ascertain what

* The theories on which the art of ship-building are founded, are very incomplete, and it is probable that the laws which govern the resistance opposed by the sea to the sailing of vessels, will still remain long exposed to conjecture more or less vague, for want of a rigorously exact point of departure. Many experiments remain to be made; but it would be necessary to conduct them on a very great scale, and those would un-

forms it would be desirable to give particular vessels to ensure them the best nautical qualities, but only to determine by analogies the general proportions, from which ought to be deduced the principal dimensions, to be assigned to these vessels.

I have equally abstained from discussing the questions relative to the tumbling home of the topsides of the ships of the line and Frigates—to the form of their extremities—to the best manner of composing their fabrics—and to the arrangements of their internal fitting.

As to the first head, it appears to me that after passing from one extreme to the other, in demanding that the topsides of ships should not fall in at all, it is now nearly agreed on all hands, that they should tumble home no more, than is absolutely necessary to carry the shrouds and lanyards, clear of the bulwarks and nettings.

Men's opinions are as yet but little settled on the propriety of round sterns. All seamen agree in admitting that it is indispensable to render the after-part of a vessel as strong as her sides; and that questionably be the best, which should be made at sea under the management of intelligent naval officers, such as France possesses many of at present. There has appeared on this subject in the "*Annales Maritimes de 1821*," 2 partie, page 789, a very remarkable paper, whose author is M. Ledean, a naval architect, as modest as he is enlightened. His reflections on this important subject are worthy in all respects of fixing the attention of naval architects and naval engineers.—Author's note.

consequently, it is necessary to do away with the windows with which the sterns of our ships of the line and frigates are ornamented. But the opponents of the new system maintain, that without at all changing the form of this part of the topsides, it might receive as much solidity as all the rest of the fabric, by only leaving in it such openings as those of the ports; that by this means great practical difficulties would be avoided, and that the stern chase-guns would have but the more room for working.

M. Dupin the engineer, who omits no opportunity of directing the attention of French naval and engineer officers, to such useful documents as he can procure, concerning the state of the arts relative to shipping among our neighbours; has lately translated a letter addressed to the first Lord of the Admiralty, by Sir Robert Seppings, Surveyor General of the British Navy, on the subject of the round sterns which have for some time been given to ships of war.* The observations of so able a man, are of

* M. Dupin has himself insisted strongly in his work on the English Navy, that we should give the sterns of our ships a round form, and as much solidity as the sides. (See his *Voyages dans le Grande Bretagne*, 2^m. partie *Force Navale*, tome II. pages 162 et suivantes.)

So far back as the year 1812, M. Montgery conceived at Venice, the idea of giving a round form to the sterns of our ships of the line and frigates, and he caused drawings to be made of them. He may therefore claim the priority in this matter, at least in the French Navy.—Author's note.

great authority in the solution of this important question; but his letter proves that in England, as well as in France, the opinions of naval officers are very much divided on the subject.

It is also to M. Dupin that we are indebted for a knowledge of the system of construction introduced by Sir Robert Seppings in the English Royal Dock-yards. A trial has been made of it with the *AMAZONE*, 24-pounder Frigate, and it is to be hoped that we shall not stop there, if, as every thing seems to prove, vessels of this construction are stronger, when they get ashore, less liable to arch,* and better fastened throughout, than those whose fabric has been built after the old methods.

For the rest, great modifications will immediately take place in the manner of building our ships, if we succeed by any system whatever, in combining pieces, so as to supersede the use of timber of large dimensions; and then, perhaps, it will be found advantageous, to unite the process which may lead to that object, with the methods of binding and fastening used by the English.

As to what relates to the fitting, and equipment,

* The *Amazone* was constructed at Brest, from the same draught as the *Jeanne D'Arc*, from which she differs only in the form of her topsides. The latter Frigate, whose fabric is formed after the ordinary methods in use in our dock-yards, had already arched 13 centimetres, about $5\frac{1}{8}$ in. when she sailed for the first time, while the *Amazone* had hardly arched from 5 to 6 millimetres (about $\frac{1}{8}$ or $\frac{1}{4}$ of an inch.)—Author's note.

of vessels of war, immense progress has for some time been making in our ports ; however, the establishment of general rules is still wanting, to put an end to the uncertainties which impede the regularity and celerity of the business of fitting out ships. But it is probable that the desires of the officers of the navy and naval engineers on this subject, will be satisfied without delay. The preparatory work of regulation has been confided to M. Boucher, an engineer whose talents and rectitude, are a sure guarantee of the care with which all the data of experience will be examined, compared, and rendered available for arriving at the best possible combinations.

Returning to what has been more particularly the subject of this Memoir, I believe that I have demonstrated ;

THAT the dimensions of our ships of the line and Frigates, are too small (with a few exceptions only,) in proportion to their force of ordnance, and the number of men which they have to carry ;

THAT the insufficiency of these dimensions is particularly remarkable in the 24-pounder Frigates, which we have lately constructed and armed ;

THAT these Frigates (otherwise very handsome and perfectly well-built,) have too little capacity for the weight which they have to carry, from which results an immersion of 27 centimetres ($10\frac{1}{8}$ in.)

more than was intended on their original draughts ; and that they carry their ports too low by 22 centimetres ($8\frac{5}{8}$ in.) notwithstanding the precaution taken to augment their fulness by 54 millimetres ($2\frac{1}{8}$ in.) ;

THAT these essential defects result from inaccuracies in calculating the weights which vessels of war have to carry, and above all, to the practice which has too long obtained, of confining within limits excessively straitened, the adjustment of the dimensions of the immersed body.

THAT these same defects have been observable in our most celebrated ships of the line, whenever a heavier calibre, or an increased number of guns, has been put into them.

THAT the present armament of our ships of the line of two decks, is no longer analogous to the force of vessels of the same rate, most recently constructed by the Americans, and which are about to be imitated by the English ; but that to change this armament, it will first be necessary to lay down larger ships of the line ;

THAT it is a disastrous error in naval matters to make economy consist in having vessels of small dimensions. They cost less indeed ; but they are more easily beaten ; and it would be to compromise the honour of the King's colours to persist in the confidence which has been placed in them hitherto.

And assuming these data, the accuracy of which appears to me to be indisputable, I have proposed ;

1st. To retain for first rate ships of the line, those of a hundred and eighteen guns constructed by Baron Sané, being most scrupulously attentive to augment in no respect the weight which they have to carry, under pretence of rendering them stronger in ordnance.

2nd. To adopt two new rates of ships of the line of two decks ;

The one, of a hundred and two guns, of which thirty two should be long 36-pounders on the lower-deck ; thirty-four 30-pounder guns on the main-deck ; and thirty-six 36-pounder carronades on the quarter-deck and forecastle ;

The other, of ninety-six guns, of which thirty, should be long 36-pounders on the lower deck, thirty-two long 24-pounders on the main-deck, and thirty-four 36-pounder carronades on the quarter-deck and forecastle.

3rd. To construct no more ships of the line, smaller than the last—those of ninety-six guns.

4th. To arm the Baron Sané's eighty-gun ships with thirty 30-pounder guns on the lower-deck, thirty-two 24-pounder guns on the main-deck, and twenty-four 30-pounder carronades on the quarter-deck and forecastle.

5th. To arm the seventy-four-gun ships which are new, or at least in very good condition, with twenty-eight 30-pounder guns on the lower-deck ;

thirty 18-pounder guns on the main-deck, and twenty-four 30-pounder carronades on the quarter-deck and fore-castle.

6th. To cut down all the seventy-four-gun ships which stand in need of thorough repair, in order to convert them into Frigates of fifty-eight 36-pounders, like the *GUERRIÈRE*.

7th. To have in future three classes of Frigates* armed with sixty pieces of ordnance (of which thirty shall be long guns, and thirty carronades,) of the calibre of 36lbs. for the first class, 30lbs. for the second class, and 24lbs. for the third.

8th. To construct no more Frigates of the same dimensions as those whose draughts were the result

* Perhaps it may be deemed superfluous to have so many classes of the new vessels, because there will be among them but little difference in their dimensions. But we must not lose sight of the circumstance that the timber with which our dock-yards are stocked, forms a progressive and uninterrupted series in respect to its size, and that the best way of bringing it all into use without occasioning waste, is to work it up for vessels whose scantlings nearly correspond. Thus, under this point of view, it can be only advantageous, to vary the dimensions of vessels of war, in such a manner as not to pass too abruptly from a moderate-sized to a very large one. It has often been observed in our ports, that there was too great a disparity between the 18-pounder Frigate, and the 74-gun ship; and notwithstanding the little difference between the latter, and the eighty-gun ship as to ordnance, it is found very convenient to be able to use for the seventy-four, timber which only wanted three or four centimetres ($1\frac{1}{8}$ or $1\frac{1}{2}$ in.) of being large enough for the frame of the eighty-gun ship.—Author's note.

of the competition opened in 1817 ; but to turn to account such of those vessels as are at present on the stocks, either by arming them with thirty long 24-pounders and twenty 24-pounder carronades (fifty guns only), or with thirty 36-pounder carronades on the main-deck, and with twenty-eight similar and two long 18-pounders on the upper-deck, which would bring their armament to sixty guns.

9th. To consider the 18-pounder Frigates as the smallest vessels of war with a quarter-deck and fore-castle which we should have ; only diminishing the excessive tumbling home of the topsides, in those which shall be constructed in future ; and to arm them with fifty guns, of which twenty-eight are to be 36-pounder carronades on the main-deck, and twenty 36-pounder carronades, and two long 18-pounders on the quarter-deck and fore-castle.

10th. To have no more vessels of war with quarter-decks and fore-castles, below Frigates armed with 36-pounder carronades ; but only two classes of flush corvettes, the one with the dimensions of our present corvettes of twenty guns ; the other similar to the *DILIGENTE*, constructed by the late M. Ozanne.

11th. To give more length and breadth, than has hitherto been done to our brigs of war.

12th. Not to endeavour to increase the number of guns on board our brigantines and schooners ; but on the contrary, rather to make them as light as possible in form and scantling ; velocity of sailing being their most essential quality.

To these principal propositions, I have added that of admitting modifications into our system of sea ordnance, which may be carried into effect at a period more or less remote, according to the sums which it may be possible to devote to them annually.

These modifications consist, in employing for the future on board the King's vessels, guns of the following descriptions only.

1st. A long 36-pounder gun, weighing one-tenth less than the present gun of that calibre.

2nd. A short 36-pounder gun, weighing only 160 times as much as its shot.

3rd. A long 30-pounder gun, in conformity with the model recently ordered.

4th. A short 30-pounder gun, weighing 160 times as much as its shot.

5th. The present long 24-pounder.

6th. A short 24-pounder, weighing 160 times as much as its shot.

7th. Carronades ; 36, 30, and 24-pounders of the models at present used ; only reserving for careful examination the question, whether it be advisable to continue to fit them with fixed breechings, or whether it would be better to leave them a recoil, which would admit of their being loaded inside the vessels.

All the guns of calibres inferior to 24-pounders should be abolished.

If this new ordnance were at present in existence in our arsenals, ships of the line and Frigates which are afloat or on the stocks, might be armed as follows :—

The 118 gun ship of the line.

On the lower deck	32 long 30-pounders,
On the middle deck	34 short 30-pounders,
On the main deck	34 carronades 30-pounders,
Quarter deck and forecastle	20 carronades 30 pounds.

Total 120

The 80 gun ship of the line.

On the lower deck	30 long 30-pounders,
On the main deck	32 short 30-pounders,
Quarter deck and forecastle	24 carronades 30-pounders.

Total 86

The 74 gun ship of the line.

On the lower deck	28 long 24-pounders,
On the main deck	30 short 24-pounders,
Quarter deck and forecastle	24 carronades 24-pounders.

Total 82

The 24-pounder Frigate of the dimensions of the *CLORINDA* :

On the main deck	30 short 24-pounders,
On the upper deck	28 carronades 24-pounders.

Total 58

As to the intended ships of the line and frigates, it would become possible to establish their armament in the following manner :—

The 102 gun ship of the line.

On the lower deck	32 new long 36-pounders,
On the main deck	34 short 36-pounders,
Quarter deck and forecastle	36 carronades 36-pounders.

Total 102

The 96 gun ship of the line.

On the lower deck	30 new long 36-pounders.
On the main deck	32 long 30-pounders,
Quarter deck and forecastle	34 carronades 30-pounders.
<hr/>	
Total 96	

The 36-pounder Frigate.

On the main deck	30 new long 36-pounders,
On the upper deck	32 carronades 36-pounders.
<hr/>	
Total 62	

The 30-pounder Frigate.

On the main deck	30 short 30-pounders,
On the upper deck	32 carronades 30-pounders.
<hr/>	
Total 62	

The 24-pounder Frigate.

On the main deck	30 short 24-pounders,
On the upper deck	32 carronades 30-pounders.
<hr/>	
Total 62	

The following table indicates the dimensions which the five new classes of vessels ought to have.

Each of these dimensions ought to be considered only as a *minimum*; and the naval architects who may be entrusted with the preparation of the plans of the new ships, being no longer straitened within too narrow limits, ought to use the latitude which may be given them, rather to increase, than to diminish, the capacities of the immersed bodies.

I shall add but one single observation in support of the propositions contained in this memoir.

Very great improvements have been for some time making in our armaments. The introduction of the 30-pounder calibre among our sea ordnance; the adoption of a new method of laying the cordage necessary for rigging, by means of the ingenious machines of Baron Lair and M. Hubert; the use which will soon be exclusive, of iron tanks for containing the water; that of iron cables, which the want of funds alone has prevented hitherto from being more general; the care required from the different departments in each port, in getting up all the details of fitting; and the attention paid to the bedding and clothes of the seamen, &c. &c. Such are the most remarkable steps which have been made towards improvement, and the officers of the navy ought to appreciate them so much the more, as they had in vain demanded some of them, during the long course of a war, which rendered all kind of progress impossible.

To stop short in this successive advancement towards perfection can no longer be permitted. The

impulse is given, and the interest of France requires that every thing relating to our shipping, shall be brought at least to a level with whatever is done best among the powers which attach importance to naval matters.

I shall have attained the end which I proposed to myself, if I have succeeded in demonstrating, the urgent necessity of adopting a better system, with regard to the real force, and dimensions, of the vessels which shall be henceforth constructed in our dock-yards.

I conclude with the expression of a wish that the Naval Engineer Officers will, by means of this work, have a wider field opened to them than that in which they have till now languished, without having an opportunity of applying to any important purpose, their theoretic knowledge and the fruits of their experience. The Royal Navy cannot but gain by this change. For, it would not be less unreasonable to suppose at this time, that Naval Architecture is susceptible of no farther improvement, than it would have been, fifty years ago, to pretend that that art could never advance beyond the limits which *Ollivier* and *Coulomb* had then succeeded in reaching.

APPENDIX.

THIS Memoir was at the press, when, upon the proposition of Lieutenant General Thirion, it was decided that there should be cast in our founderies, short 30-pounder guns, weighing about 2700 kilogrammes, or nearly 180 times as much as their shot.

While I cannot but regret that it has not been deemed possible, to make a wider difference in the weight of guns of the same calibre, which are intended to arm the lower and main decks of a ship of the line ; it seems to me incontrovertible, that the adoption of the new gun, presents very great advantages.

I believe then, that I ought to consider this innovation as *the only admissible basis* for the establishment of a better system of armament ; and it follows, that my first propositions stand in need of being modified.

The short 30-pounder gun, fulfilling all the conditions required in a good piece of ordnance, we are led by analogy to conclude, that the same success would be obtained for 36 and 24-pounder guns, weighing equally 180 times as much as their shot.

Thus, then, setting aside all supposition at hazard, and, *in the event of the 36-pounder calibre being persisted in*, the new vessels which I have proposed to construct, might be armed as follows ;—

1. The 102-gun ship of the line.

On the lower deck	32 long 36 pounds.
On the main deck	34 short 36 pounds.
Quarter deck and forecastle	36 carronades 36 pounds.

Total 102

2. The 96-gun ship of the line.

On the lower deck	30 long 30-pounds.
On the main deck	32 short 30-pounds.
Quarter deck and forecastle	34 carronades 30 pounds.

Total 96

3. The 36-pounder Frigate.

On the main deck	30 short guns 36-pounds.
On the upper deck	32 carronades 36-pounds.

Total 62

4. The 30-pounder Frigate.

On the main deck	30 long guns 30-pounds.
On the upper deck	30 carronades 30-pounds.

Total 60

5. The 24-pounder Frigate.

On the main deck	30 long guns 24-pounds.
On the upper deck	30 carronades 24 pounds.

Total 60

But in the very probable hypothesis, that the opinion of naval men, who consider it preferable to renounce the 36-pound calibre entirely, should pre-

vail, our system of naval armament might be established as follows;—

1. The 120-gun ship of the line.

Lower deck	32 long guns 30-pounders.
Middle deck	34 short guns 30-pounders.
Main deck	34 carronades 30-pounders.
Quarter deck and fore-castle	20 carronades 30-pounders.

Total 120

For this ordnance, the three-decked ship of the line, fitted on the war-establishment, would only require a complement of 990 men, instead of 1070. The total weight she would have to carry, with provisions for six months, and water for 120 days, and 650,000 kilogrammes of ballast, would be 2643 metrical tons, ($2604\frac{1}{8}$ tons.)

In this state, the ship would only retain 1 met. 68 cents. ($5\text{ ft. }6\frac{1}{8}\text{ in.}$) height for her ports; but as the real weight of the guns and their carriages would be much less, there could be no inconvenience from increasing the fulness of this ship by 17 centimetres, ($6\frac{5}{8}\text{ in.}$) in order to augment by so much, the height of her midship port from the water. This height would then be 1 met. 85 cents. ($6\text{ ft. }0\frac{7}{8}\text{ in.}$); and after the first thirty days at sea it would be found to be, through the consumption of provisions, 1 met. 95 cents. ($6\text{ ft. }4\frac{3}{4}\text{ in.}$)*

* It might be 1 metre 95 centimetres even at the time of sailing, because owing to the increased stability which results from the use of iron tanks, it would be possible to diminish the ballast, notwithstanding the increase of fulness.—Author's Note.

2. The 102-gun ship of the line.

Lower deck	32 long guns 30-pounders.
Main deck	34 short guns 30-pounders.
Quarter deck and forecastle	36 carronades 30-pounders.

Total 102

The 102-gun-ship of the line, being armed with 30-pounder guns, there would no longer be a reason for having a ship of 96, which would only differ from her by six guns of the same calibre.

But on the other hand, the distance will probably be found to be too great, between the 102-gun-ship of the line, and the 60-gun Frigate, both armed with 30-pounder guns; and in this case it might appear desirable to retain an intermediate ship of the line, differing but little from the present 80-gun-ship, and carrying like her 86 guns; but whose capacity should be such that she might stow eight months' provisions and 120 days' water, and carry her ports at a height of 2 metres, (6 ft. $6\frac{3}{4}$ in.)

This ship should have the following armament.

3. The 86-gun ship of the line.

Lower deck	30 long guns 30-pounders.
Main deck	32 short guns 30 pounders.
Quarter deck and forecastle	24 carronades 30-pounders.

Total 86

Then would follow two classes of 60-gun Frigates, viz. :—

4. The 30-pounder Frigate.

On the main deck	30 long guns 30-pounders.
On the upper deck	30 carronades 30-pounders.

Total 60

5. The 24-pounder Frigate.

On the main deck 30 long guns 24-pounders.

On the upper deck 30 carronades 24-pounders.

 Total 60

6. Lastly, The present 18-pounder Frigate, converted into a 50-gun Frigate.

On the main deck 28 carronades 30-pounders.

On the upper deck 22 carronades 30-pounders.

 Total 50

It is to be observed that with this system of armament, there would only be employed long and short 30-pounder guns, long 24-pounders, and carronades of those two calibres, all pieces which are either now in our parks, or which are ordered to be cast; and there would be no other reason for having short 24-pounders, except to arm our remaining 74-gun ships, or the present 24-pounder Frigates, which even might in strictness be dispensed with.

The following Tables, calculated on the data established in the course of the preceding Memoir, indicate the weight to carry, and the dimensions of the six principal classes of vessels, which we have seen the Fleet might be composed of, *if the 36-pounder calibre were entirely abolished.*

	SHIPS OF THE LINE.						SIXTY-GUN FRIGATES.				Frigates of 50 30-pounder carronades.	
	Of 120 guns.		Of 102 guns.		Of 86 guns.		Mounting 30-pounders.		Mounting 24-pounders.			
	French met. tons.	English tons.	French met. tons.	English tons.	French met. tons.	English tons.	French met. tons.	English tons.	French met. tons.	English tons.		
ORDNANCE.												
Number of long guns 30 pounders		32		32		30		30				
Do. short guns 30 pounders		34		34		32				30		50
Do. long guns 24 pounders								24		30		
Do. carronades 30 pounders		54		36								
Do. do. 24 pounders												
Complement of Men		990		870		785				480		260
WRIGHT TO CARRY.												
ORDNANCE and its appurtenances	557	548.81	502	494.62	441	434.52	272	268.00	230	226.62	155	152.72
MASTS, rigging, and stores	396	390.18	360	354.71	306	301.50	216	212.83	190	187.21	126	124.15
WEIGHT of the MEN and their effects, { for six months	89	97.54	87	85.72	78	76.85	48	47.29	46	45.32	26	25.62
PROVISIONS { for eight months	805	497.58	592	583.30	534	526.15	408	402	391	385.25	177	174.40
WATER for 120 days	376	370.47	330	325.15	298	293.62	182	179.32	175	172.43	99	97.54
PROVISIONS of the CAPTAIN and OFFICERS	20	19.71	16	15.76	12	11.82	7	6.90	6	5.91	5	4.93
BOATS and various articles	40	39.41	38	37.44	33	32.51	23	22.66	21	20.69	12	11.82
BALLAST	650	640.45	450	443.38	380	374.41	210	206.91	200	197.06	160	157.65
Total weight to carry	2,643	2,604.15	2,375	2,340.08	2,082	2,051.38	1,366	1,345.91	1,259	1,240.49	760	748.83
Weight of the HULL	2,200	2,167.66	2,000	1,970.60	1,700	1,675.01	1,200	1,182.36	1,075	1,059.20	700	689.71
TOTAL WEIGHT OF THE VESSEL	4,843	4,771.81	4,375	4,310.68	3,782	3,726.39	2,566	2,528.27	2,334	2,299.69	1,460	1,438.54
Volume of immersed body	4,720	1,666.96	4,264	1,505.92	3,686	1,301.78	2,500	882.93	2,275	803.46	1,423	502.56

PRINCIPAL DIMENSIONS.*	SHIPS OF THE LINE.						SIXTY-GUN FRIGATES.						Frigates of 50 30-pounder carronades.						
	Of 120 guns			Of 102 guns.			Of 86 guns.			Mounting 30-pounders.					Mounting 24-pounders.				
	French met. cen.	English in.		French met. cen.	English feet in.		French met. cen.	English feet in.		French met. cen.	English feet in.				French met. cen.	English feet in.		French met. cen.	English feet in.
Length on the line of floatation,	63 80	209	3	62 00	203	5	59 00	193	6½	54 00	177	2	53 00	173	10½	47 00	154	2½	
Breadth moulded	16 40	83	9	16 30	53	5½	15 50	50	10½	14 10	46	3	13 70	44	11½	12 00	39	4½	
Depth of immersed body amid- ships	7 25	23	9½	7 00	22	11½	6 66	21	10½	5 76	18	10½	5 60	18	4½	4 90	16	1	
Height of the ports above the water	1 85	6	0½	2 00	6	6½	2 00	6	6½	2 00	6	6½	2 00	6	6½	2 00	6	6½	
Height of the portall above the beam amidships	0 80	2	7½	0 80	2	7½	0 80	2	7½	0 78	2	6½	0 75	2	5½	0 65	2	1½	
Depth of the hold amidships ..	8 30	27	2½	8 20	26	10½	7 86	25	9½	6 98	22	10½	6 85	22	5½	6 25	20	6	
Depth of the keel and false keel,	0 65	2	1½	0 60	1	11½	0 58	1	10½	0 56	1	10	0 55	1	9½	0 50	1	7½	
Total draught of water amidships	7 90	25	11	7 60	24	11½	7 24	23	9	6 32	20	8½	6 15	20	2½	5 40	17	8½	

* The three dimensions of the immersed body of the Ship of the Line of 120 guns, are those of the three-decked ships most recently constructed in our dock-yards, supposing them to carry their ports at a height of 1 metre 68 centimetres (5ft. 6½ in.)

The dimensions of the immersed body of the Frigate carrying fifty 30-pounder carronades, differ only from those of the present eighteen-pounder Frigates, in the omission of some small metrical fractions.

The height of the portall above the beam amidships, in the Ships of the Line, is here only 80 centimetres (2 ft. 7½ in.) because of the substitution of thirty-pounder guns for those of thirty-six.

POSTSCRIPT.

Extracts from the Speech pronounced in the Chamber of Deputies, on the 30th of June, 1829, by His Excellency the Minister of Marine, (M. Hyde de Neuville,) on the subject of the Budget of his Department.

“ Let me answer the reproach which has been made, ‘ that we construct more Ships of the Line than Frigates, and that we are preparing to form fleets of the former only.’

“ I will not examine here, what system of naval warfare France would have to follow, if she were under the necessity of contending against a powerful enemy ; but this I know, that it would be incompatible with sound reason to adopt any exclusive system. A great Captain observed to me one day, ‘ that there was no readier way of getting beaten in war, than to lay down before-hand fixed rules of attack and defence ; and to arrange the whole plan of a campaign from a cabinet. The system to follow,’ added he, ‘ is that which is pointed out, and rendered necessary, according as the enemy is to be resisted or assailed.’ Now, this is what we have to answer to those who believe they can resolve a question which no good naval officer would venture to pronounce upon in so decided a manner as they do.

“ Assuredly, if war broke out, it is probable that we should be little inclined to fighting in fleets. We have other means of contending with success ; especially since Steam Navigation permits us to hope that henceforward, rigorous blockades will be nearly impossible. For, it must be said, that it was by closing our Ports, and thus depriving our fleets of all assistance, that the enemy generally succeeded in wresting victory from us.

“ But, is the reproach which I am answering, well founded? Gentlemen, you shall judge,

We had after the Peace of 1814—73 Ships of the Line.

in 1816—72 do. do.

in 1817—68 do. do.

in 1819—65 do. do.

in 1824—61 do. do.

in 1825—59 do. do.

in 1828—56 do. do.

We shall have on the 1st. Jan. 1830 } 52 do. do.
afloat, and under construction, only }

A reduction from 1814 to 1830 of 21 Ships of the Line.

We had in 1814—42 Frigates.

in 1823—45 do.

in 1824—47 do.

in 1828—52 do.

We have in 1829—53 do.

We shall have on the 1st. Jan. 1830 } 63 do.
afloat, and under construction . . }

Increase from 1814 to 1830 21 Frigates more.

Thus from 1814 to 1830, we shall be found to have effected

A reduction of 21 Ships of the Line.

An increase of 21 Frigates.

“ You see, Gentlemen, that we have been for several years pursuing the course which we are reproached with not following. I shall add, that five Ships of the Line were to have been constructed in 1830; I have ordered them to be replaced upon the stocks by double the number of Frigates.”

After stating that the limits of his supplies had compelled him to diminish the total number of new constructions, and thorough repairs for the years 1829, and 1830, His Excellency went on to say:

“ It must, however, not be dissembled, Gentlemen, that

this diminution to which I have been forced in the number of our constructions, holds out to us a prospect for the future, which is but little satisfactory. All that we re-trench from the annual mass of work, throws back by so much, the accomplishment of a system, which was conceived with a wise prudence; and which up to this time has, for want of sufficient supplies, experienced the greatest difficulties in its development."

The two following statements are extracted from a Report addressed by the same Minister to the King his Master, in December, 1828.

ACCOUNT OF THE VESSELS UNDER CONSTRUCTION ON THE
1st OF JANUARY, 1829, AND OF THOSE WHICH WILL BE
LAID UPON THE STOCKS IN THE COURSE OF THE YEAR.

	Vessels which will be worked upon in 1829.	To deduct vessels which will be launched in 1829.	Vessels which will be on the Stocks 31st Dec. 1829.	Vessels which will be laid on the Stocks in 1830.	Vessels which will be worked upon in 1830.	To deduct vessels which will be launched in 1830.	Vessels which will be on the Stocks 31st Dec. 1830.
Ships of the Line	21	1	20	1	21		21
Frigates	22		22	10	32	1	31
Corvettes of War	9	2	7	4	11	6	5
Brigs of 20 guns	5	2	3	4	7	3	4
Dispatch Corvettes	2	1	1		1	1	
Dispatch Brigs	4		4	5	9	3	6
Cutters, Luggers, Advice-Boats, &c.	1	1					
Steam Vessels	7		7	2	9	2	7
Transports Corvettes	5		5		5		5
Vessels of Burden	4		4	2	6	1	5
Total	80	7	73	28	101	17	84

ACCOUNT OF THE VESSELS AFLOAT ON THE 1st OF JAN. 1829.

	Vessels afloat on the 1st January, 1829.	Vessels which will be launched in 1829.	Total.	To deduct vessels which will be surveyed and probably condemned in 1829.	Presumed to exist on the 1st of January, 1830.
Ships of the line of the	1st Rate.. 8		8		8
	2nd do. .. 10	1	11	1	10
	3rd do. .. 15		15	1	14
	4th do. .. 11		11		11
Frigates of the	1st Class, 9		9		9
	2nd do. .. 21		21		21
	3rd do. .. 5		5		5
Corvettes of War	of 32 guns, 1	2	3		3
	of 24 guns. 25	2	27		27
Brigs of 20 and of 16 guns.....	8	1	9		9
Dispatch Corvettes of 18 guns	15		15		15
Dispatch Brigs of 14 guns.....	2		2		2
Brigantines of 16 guns	6		6		6
Small Brigs.....	34		34		34
Gun Brigs.....	15	1	16		16
Schooners	27		27	1	26
Cutters, Luggers, Advice-Boats, &c.	9		9		9
Gun Vessels.....	15		15		15
Steam Vessels.....	4		4		4
Transport Corvettes of 800 tons....	20		20		20
Vessels of burthen 450 to 550 tons,	13		13	1	12
Ditto 300 to 400 do.	4		4		4
Ditto 200 to 250 do.	4		4		4
Transports.....	277	7	284	4	280
Yachts.....	2		2		2
Total.....	279	7	286	4	282

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